

INSTRUCTION MANUAL

FOR THE

NATIONAL MODEL NC-98

RADIO RECEIVER

SECTION 1. DESCRIPTION

1-1. GENERAL

The Model NC-98 is an excellent example of a communications-type receiver with that fine performance and rugged dependability so typical of all National Company products. The NC-98 has been designed to fill the needs of many varied classes, from the Amateur and Short Wave listener to the many commercial services and civil defense groups.

Eight miniature type tubes plus rectifier are utilized in the NC-98 in a modern superheterodyne circuit with a continuous frequency coverage of 540 kilocycles to 40 megacycles. Both voice and code telegraphy reception are provided to permit world-wide coverage over the entire range. The complete frequency coverage of the NC-98 is separated into four bands, with the entire Main Tuning dial and the Bandspread dial calibrated in megacycles. A logging scale on the Bandspread dial permits relative calibration of bandspread tuning anywhere within the range of the receiver, while clear markings on both dials, including location of the new civil defense frequencies, contribute greatly to ease of operation.

The NC-98 circuitry includes a crystal filter and an S meter to make the receiver truly efficient on today's crowded bands.

A phono jack has been installed on the rear of the NC-98 to accommodate most types of record players in use today, permitting the receiver to be used for music reproduction. Powerful, faithful audio is delivered to the output terminals, while a two-position tone switch gives the listener his choice of crisp treble or rich bass response. The delayed automatic gain control circuit compensates for fluctuations in the strength of the received signal due to atmospheric conditions, etc., while an extremely effective automatic noise limiter circuit provides maximum suppression of most types of objectionable noise.

An accessory socket is mounted at the rear of the

receiver to accommodate auxiliary apparatus such as an FM adapter, etc.

Two edge lighted slide-rule type lucite tuning dials add greatly to the handsome appearance of the steel cabinet enclosure making the NC-98 a distinctive addition to any room, while soft feet prevent marring of furniture.

1-2. CRYSTAL FILTER

One of the outstanding features of the NC-98 Receiver is its variable selectivity made possible by the crystal filter. The crystal filter provides three degrees of selectivity which enables the operator to successfully tune in code or voice signals on crowded bands and reject strong interfering signals. The Selectivity switch adjusts the crystal filter to the degree of selectivity needed and the Phasing control serves to nullify interfering signals.

1-3. S METER

An S meter mounted on the front panel greatly facilitates accurate tuning and also shows the relative strength of incoming signals. Signal input readings are indicated in S units from 1 to 9 and in decibels above S9 from 0 to 40 decibels. The meter may be adjusted to its electrical zero by means of an adjustment screw located at the rear of the chassis.

1-4. AUDIO OUTPUT

A built-in audio transformer provides audio at the Speaker terminal strip located at the rear of the receiver and will match a 3.2 ohm speaker voice coil. A National type NC-98TS permanent magnet speaker is recommended for use with the NC-98. Audio is also available at the phones jack located on the front panel. The headphone load impedance is not critical, permitting use of a wide variety of headphones. Insertion of headphones into the jack automatically silences the speaker.

1-5. POWER REQUIREMENTS

The NC-98 requires a 105-130 volt, 50/60 cycle A.C. source of supply. Power consumption is approximately 62 watts.

1-6. FREQUENCY COVERAGE

The frequency range of the NC-98 is from 540 kilocycles to 40 megacycles. The purchaser of an NC-98 has a choice of one of two bandspread dials. One is specifically intended for use by the Amateurs, the other will best serve the Short Wave listener (NC-98SW). The amateur bandspread dial is calibrated for the 10, 15, 20, 40 and 80-meter bands. The short wave bandspread dial is calibrated for the 17, 19, 25, 31 and 49 meter bands. The following table gives the frequency of each band tuned by the NC-98 along with the letter designations of each band.

Band	Frequency Range	Calibrated Bandspread	
		Amateur	Short Wave
A	540 to 1600 kc.		
B	1.6 to 4.7 mc.	80 meters	
C	4.7 to 14 mc.	40 meters	25, 31 and 49 meters
D	14 to 40 mc.	10, 15 and 20 meters	17 and 19 meters

1-7. CONTROLS

The following controls appear on the front panel of the NC-98:

Antenna Band

Main Tuning	Reception
A.C. Off-Volume	(CWO-MVC-AVC-ANL)
Bandspread Tuning	Pitch
Sensitivity	Receive-Standby
Phasing	Tone
Selectivity	

1-8. CIRCUIT

The stage associated with each of the nine tubes used by the NC-98 is given below, opposite the tube type.

Tube Type	Stage
6BA6	R.F. Amplifier
6BE6	Mixer
6C4	H.F. Oscillator
6BD6	1st I.F. Amplifier
6BD6	2nd I.F. Amplifier
6AL5	Detector, AVC and ANL
12AX7	1st Audio, CWO and Meter Amplifier
6AQ5	Audio Output Amplifier
5Y3GT	Rectifier

1-9. ACCESSORY SOCKET

The accessory socket mounted at the rear of the receiver is designed to accept a National Model NFM-83-50 Narrow Band FM Adapter. B plus and filament voltages are available at this socket, the maximum permissible drain being 0.6 amperes at 6.3 volts A.C. and 15 ma at 200 volts D.C. See the schematic diagram for pin connections, etc. Refer to Section 3 for instructions on FM adapter operation.

SECTION 2. INSTALLATION

2-1. INSTALLATION PROCEDURE

Carefully remove the NC-98 from its packing box and proceed as follows:

1. Raise the hinged cover of the receiver by means of the two slots provided at the sides and make sure all tubes are seated firmly in their sockets.

2. Referring to Figure 1, locate the antenna terminal strip at the rear of the cabinet. Connections to this terminal strip are made by loosening the screw to be used and then wrapping the wire around the screw and tightening with a screwdriver so that the wire is held securely. The method to use in connecting the antenna to the receiver is as follows:

a. Single-Wire Type-The lead-in wire is connected to the left hand A terminal on the antenna terminal strip and the other A terminal is connected to the G terminal by means of the metal link provided (see Figure 1).

b. Doublet Type-Connect each lead-in wire to a separate A terminal on the antenna terminal strip and disconnect the metal link from the A terminal.

c. Concentric Transmission Line (Coaxial Cable) Type-Connect the inner wire to the left hand A terminal on the terminal strip and the braided copper shield to the other A terminal, connecting this to the G terminal by means of the metal link.

3. Connect a wire from a good external ground (water pipe, radiator, etc. with the paint scraped

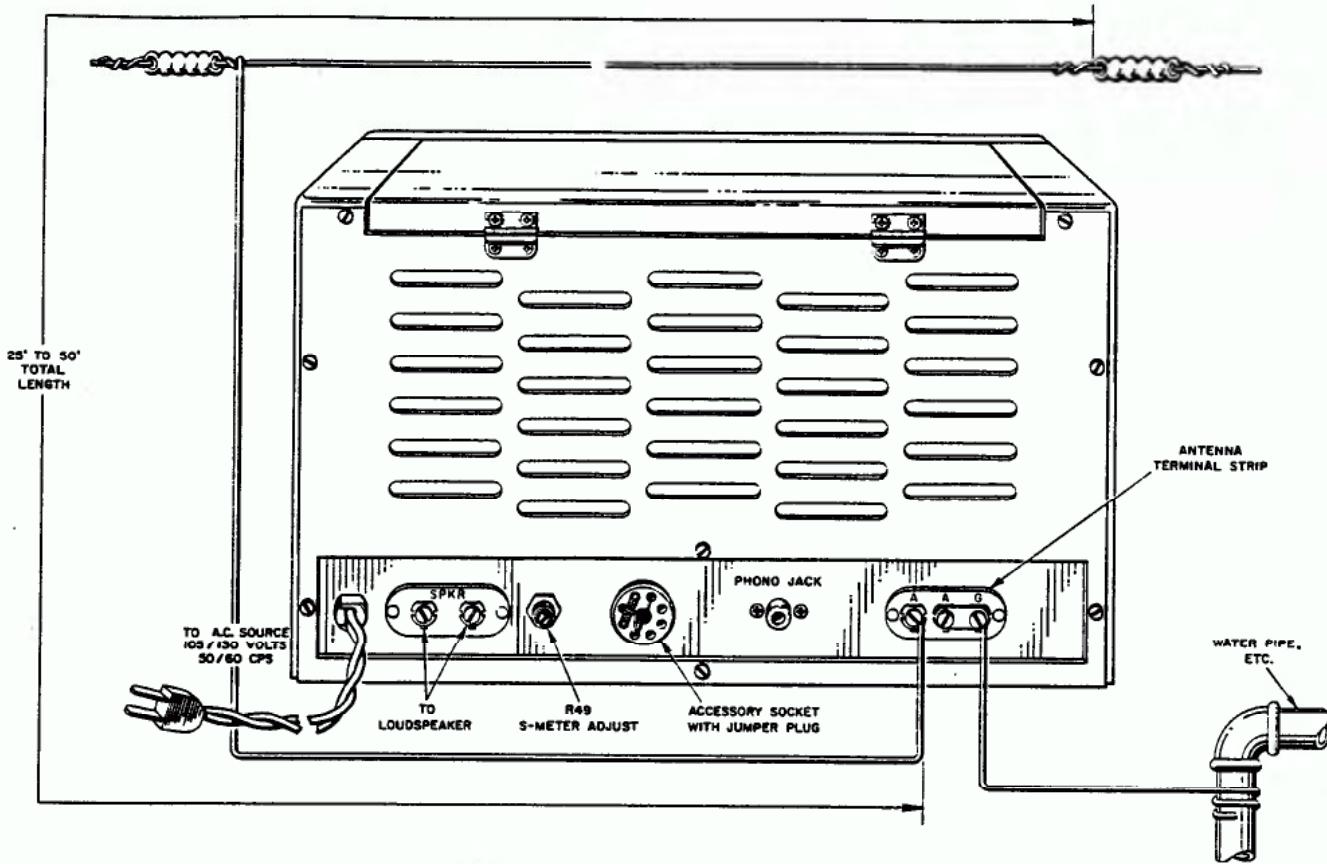


Figure 1. Typical Installation Plan

off at the point of connection) to the terminal marked G on the terminal strip. This connection is not absolutely necessary but in certain localities a considerable reduction in noise may be effected.

4. Check that the receiver is turned off by rotating the A.C. Off-Volume control to the extreme counterclockwise position.

5. Connect the power cord to a 105/130 volt, 50/60 cycle A.C. line. NOTE: Do not under any circumstance connect to a D.C. power line as serious damage to the receiver will result.

Your NC-98 is now ready for immediate operation; see Section 3 for a discussion of operating procedure.

2-2. ANTENNA RECOMMENDATIONS

The antenna input circuit of the NC-98 has been designed with a characteristic impedance of approximately 300 ohms but any mismatch will be compensated for by the antenna trimmer control and need not cause concern.

The NC-98 is designed to operate efficiently with various types of antennae, making it readily adaptable to any installation, from one using simply a single wire to those using the most elaborate array tuned for a particular frequency. Where the receiver is to be used in a transmitting station probably the most effective solution is to connect the transmitting antenna to the receiver when the transmitter

is not actually on the air. This may be accomplished by means of a suitable relay designed for antenna switching purposes. However, for most installations where the receiver is to be used over a wide range of frequencies, the single wire type of antenna is recommended and is described below. Details on other types may be found in any of the numerous antenna books now on the market.

The single wire type of antenna is, as its name implies, merely a single length of wire which may or may not have an insulated covering. A total length of from 25 to 50 feet is recommended (i.e., the length of wire from the receiver to the far end of the antenna) although this is not critical. The wire should be as high as possible and in the open, strung between two poles, the house and a pole, etc. with the wire insulated from the poles. One end of the wire is brought into the operating room and connected to the receiver, using standoff insulators to prevent the wire from touching the house. It is not advisable to string the antenna to a tree unless some sort of strain relief is provided to allow for swaying of the tree in high winds which could cause the antenna to snap. NOTE: Extreme care must be taken when stringing the antenna in the vicinity of power lines. The antenna should be far enough away so that if it should snap it won't fall across these lines and cause a deadly short circuit.

SECTION 3. OPERATION

This section on operation of the NC-98 Receiver is presented to provide the operator with a clear understanding of his receiver in the shortest possible time, enabling him to operate it easily and efficiently.

3-1. CONTROLS

This discussion of controls is introduced prior to the actual operating instructions primarily to induce the layman to overcome that compelling urge to "turn it on and see how the thing works". If he conscientiously reads this section and gains an understanding of the receiver instead of plunging headlong into the ether and perhaps being overcome by the seemingly garbled and innumerable transmissions being made, he will be able to calmly turn on the receiver and efficiently adjust the controls, the resultant being a source of never-ending listening enjoyment.

Proceeding from the left-hand side of the front panel the controls are:

Selectivity switch -- this control varies the bandwidth of the crystal filter from maximum selectivity at position 2 to minimum selectivity at the Off position. Position 1 is an intermediate point of selectivity.

Phasing -- the capacity of the crystal holder is balanced out by adjustment of this control to give maximum selectivity. In addition, this control may be used to nullify interfering code signals.

Sensitivity -- determines the sensitivity (ability to receive weak or distant signals) of the receiver. For normal voice reception, this control is left full "on" (extreme clockwise position). In the immediate vicinity of an exceptionally strong broadcast station, however, the Sensitivity control may be adjusted to prevent overload of the receiver.

For proper adjustment of the Sensitivity control for CW operation refer to paragraph 3-5.

Antenna -- intended to compensate for the many different types of antennae accommodated by the NC-98. That position which produces maximum S meter reading (and/or a definite rise in receiver background noise) is the optimum setting for a given frequency and antenna length and the Antenna control should be set at that position.

Band -- a four-position switch used to determine the band of frequencies tuned by the receiver as indicated by the position of the red dot. When this switch is rotated the dot will be seen to stop at each of the letters A, B, C and D marked on the front panel designating the four bands tuned and corresponding to the identifying letters on the main

tuning dial scales.

Main Tuning -- serves to vary the frequency of the receiver as indicated by the moveable pointer on the left-hand dial. This control corresponds to the tuning control on the ordinary home radio and performs the same function, that of tuning in stations.

Bandspread Tuning -- performs essentially the same function as the Main Tuning control in that the receiver may be tuned using either. However, the Bandspread control performs a very valuable service by providing extremely fine tuning, enabling the operator to separate stations from one another much more easily than with the Main Tuning control. This feature will be found very useful on the crowded foreign and amateur bands where a number of stations occupy a very small portion of the main dial. For example, approximately seven complete rotations of the Bandspread control are required to change the frequency of the receiver the same amount as one complete rotation of the Main Tuning control.

Reception switch (CWO-MVC-AVC-ANL) -- allows the operator to select the different modes of operation. For normal voice or broadcast operation, this control should be placed in the AVC (automatic volume control) or MVC (manual volume control) positions depending upon whether or not AVC voltage is desired. In the MVC position no AVC voltage is available; volume control is accomplished by using the manual volume control. If the noise limiter is needed, as well as AVC, place the reception switch in the ANL position. For code reception, the switch should be placed in the CWO position. When in the CWO position an audible tone of varying pitch is heard as the receiver is tuned to a station, this note being necessary for code reception but undesirable for voice. The CWO position also disables the automatic volume control to eliminate the possibility of the CW oscillator overloading the AVC circuit and reducing the sensitivity of the receiver.

Pitch -- provides a means of varying the pitch of the tone heard when the reception switch is in the CWO position and a signal is being received, this control being inoperative when the Reception switch is in the other positions. Using the Pitch control the operator may select that note which is most pleasing to his ear for minimum listening fatigue over long periods of time.

Receive-Standby -- provides a means of quieting the receiver during transmission or other periods when it is desirable to resume reception without having to wait for the tubes to warm up. For normal reception this switch is kept in the Receive position. It MUST NOT be used to turn the receiver off since there is a power drain in either position with the

A.C. Off switch turned on.

Tone switch -- gives the operator his choice of two tonal ranges depending upon the type of signal being received and his personal preference. The Tone position produces a crisp, clear signal while the Low position imparts a rich bassness to music, etc.

A.C. Off-Volume -- corresponds to the volume control and on-off switch on the ordinary home radio, performing the dual function of turning the receiver on and off and controlling the audio volume. All power to the receiver is turned off with this control in the extreme counterclockwise position and turned on as it is rotated a small amount clockwise, the extreme clockwise position producing maximum volume.

3-2. DIAL MARKINGS

Two slide-rule type tuning dials are used with the NC-98, one the Main Tuning dial and the other the Bandspread Tuning dial. The Bandspread dial will be calibrated either for the short wave bands or the amateur bands. This paragraph is intended to give the operator an understanding of the marking system employed on each. During this discussion the operator should refer to the receiver itself in order to verify the points brought out.

The Main Tuning dial has four scales marked A, B, C and D corresponding to the four bands of frequencies tuned by the NC-98, the position of the red dot on the Band switch indicating which of these scales is to be read. For example, if the Band switch is in the B position you would read the B scale, the second from the top. Heavy white lines have been placed on certain portions of the short wave bands corresponding to important frequencies along with a letter to designate the agency which uses each. That is, the letter A above a heavy white line indicates a band used chiefly by amateurs, while the letter F denotes use by foreign countries, the letter S, ships, and P, police. There are also small white circles at various points on the scales enclosing an identifying number or letter. These circles indicate the correct setting of the Main Tuning dial pointer when Bandspread Tuning is to be used on that band and are discussed in the paragraph on Bandspread Tuning. The two circles enclosing the letters CD on the broadcast band, however, indicate the two civil defense frequencies and are dealt with in the paragraph on those frequencies.

The Bandspread dial has five scales calibrated directly in megacycles plus a logging scale graduated from 0 to 100. These scales are identified by a letter to indicate the receiver band to be used and a number to indicate the portion of the band being

tuned, with the exception of the logging scale which is identified by the word "Log". The Log scale serves as a means for relative calibration on any band within the range of the receiver. The word "Set" enclosed by a circle is placed near 86 on the Log scale to indicate the correct position of the Bandspread pointer when tuning is being done with the Main Tuning control. The bandspread pointer MUST be on the SET mark for calibration of the main dial to be accurate.

3-3. TUNING

Tuning of the NC-98 is accomplished by means of either the Main Tuning or Bandspread controls. Remember this: the calibration of the Main Tuning dial is accurate ONLY when the bandspread pointer is on the Set mark. With the Bandspread control properly set, tuning is accomplished by turning the Main Tuning control and reading the frequency directly from the Main Tuning dial. Similarly the main tuning pointer must be at the proper setting to insure correct bandspread tuning calibration.

Bandspread tuning of the receiver offers this as its chief advantage: it enables the operator to spread a portion of any band over a larger range than is possible with the main tuning control. Where a large number of stations are crowded together such as on the foreign or amateur bands, the bandspread control permits them to be separated from each other much more easily than with the Main Tuning control so that only one signal is received at a time.

If the receiver is equipped with a Bandspread dial calibrated for the amateur bands, the upper limits of the 10, 15, 20, 40 and 80-meter bands are located on the Main Tuning dial in the centers of white circles each enclosing a number identifying one of these bands. For example, to tune the 40-meter band (7.0 to 7.3 mc), set the Band switch on band C since the 40-meter band is located on the scale marked C on the Main Tuning dial. Then set the Main Tuning dial pointer to the center of the circle enclosing the number 40. With the pointer in this position the receiver is tuned to 7.3 mc. which is the upper limit of the 40-meter amateur band. Now, using the Bandspread Tuning control, tune the 40-meter band on the second scale from the top of the Bandspread dial within the area of the heavy white line (7.0 to 7.3 mc.).

If the receiver is equipped with a Bandspread dial calibrated for the short wave bands, the upper limits of the 17, 19, 25, 31 and 49-meter bands are located on the Main Tuning dial in the centers of the white circles each enclosing a number identifying one of these bands. For example, to tune the 25-meter short wave

band (11.7 to 11.9 mc.), set the Band switch on band C since the 25-meter band is located on the scale marked C on the Main Tuning dial. Then set the Main Tuning dial pointer in the center of the circle marked 25. With the pointer in this position the receiver is tuned to 11.9 mc., the upper limit of the 25-meter band. Now, using the Bandspread Tuning control, tune the 25-meter band on the third scale from the top on the Bandspread dial in the area within the heavy white line (11.7 to 11.9 mc.).

To utilize the bandspread tuning feature on any band within the frequency range of the Receiver proceed as follows: set the Band switch to the receiver band to be tuned and set the main tuning pointer at the upper limit of the range of frequencies to be tuned. The receiver may now be tuned with the Bandspread control, using the Log scale for relative calibration. That is, the frequency may be approximated by noting the position of the pointer on the Log scale.

It will be noticed by the operator that certain frequencies seem to have a large number of stations operating at certain times while at other times there is no activity at all. It has been found that the amount of activity one can expect on a given frequency is largely dependent on the time of day and season of year and can be predicted with reasonable

accuracy. However, it should be borne in mind that bands of frequencies above 18 megacycles are very unpredictable and under adverse conditions reception will be very poor. The following table gives the approximate frequencies in megacycles of foreign broadcast bands and the approximate time of day and season of the year when best reception may be expected on those bands.

	<u>Summer</u>	<u>Spring-Fall</u>	<u>Winter</u>
Morning	15, 20 mc.	14, 18, 20 mc.	6, 20 mc.
Afternoon	6, 12 mc.	12, 14, 18, 20 mc.	6, 11, 14, 18, 20 mc.
Evening	6, 15, 20 mc.	6, 12, 14, 18, 20, 27, 33 mc.	6, 9, 14, 18 mc.

3-4. VOICE OR MUSIC RECEPTION

This paragraph outlines the correct procedure to be followed when operating the NC-98 for voice or music reception and should be followed closely until the operator gains some degree of familiarity with his receiver. To facilitate tuning of the standard broadcast band all control settings to be observed have been marked in orange. Figure 2 contains pictorially the same information as is given in this paragraph.

Having installed the receiver as described in

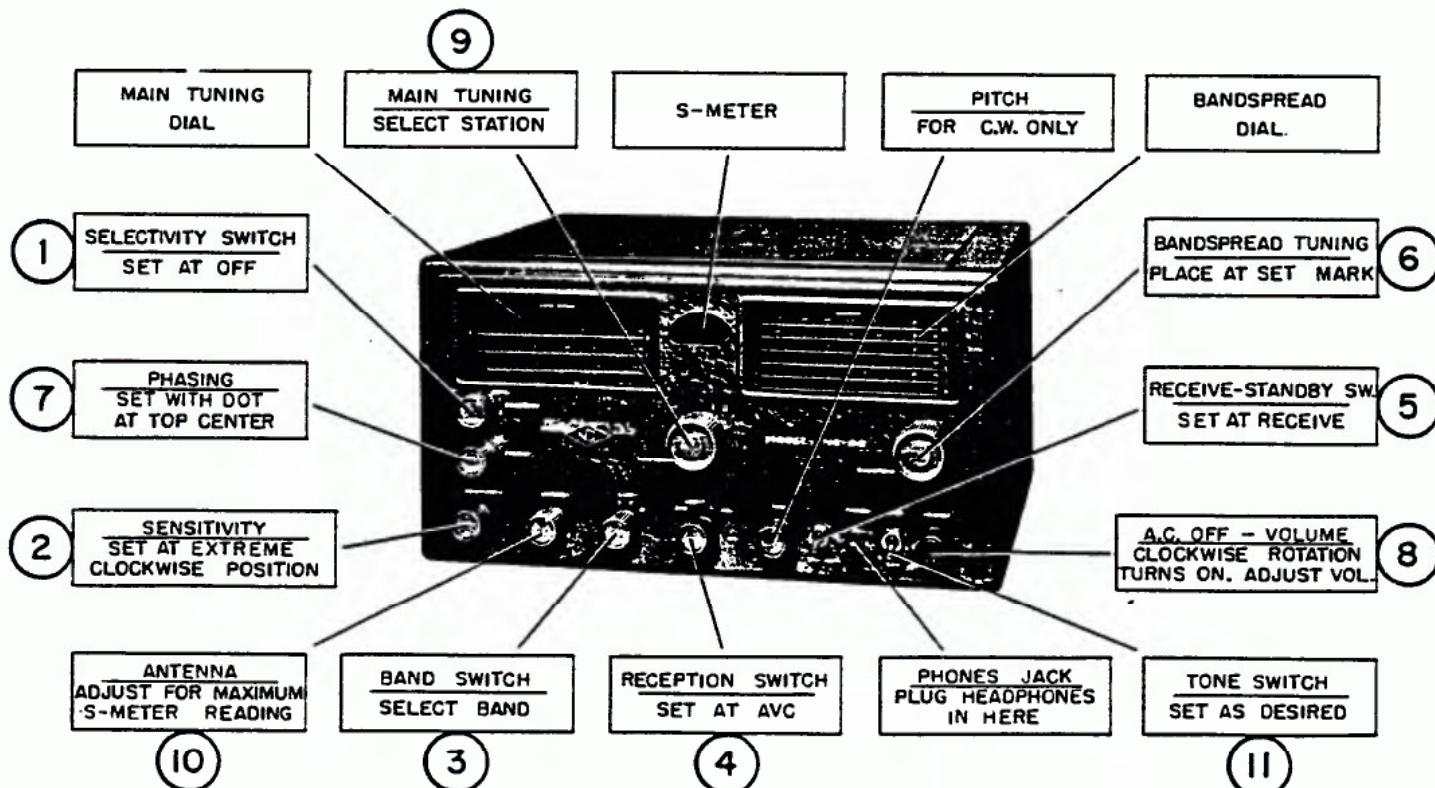


Figure 2. Simplified Operating Instructions for Broadcast Reception

Section 2, proceed as follows:

1. Place the Selectivity switch in the Off position.
2. Rotate the Sensitivity control to the extreme clockwise position.
3. Turn the Band switch to the band to be used.
4. Place the Reception switch in the AVC position.
5. Place the Receive-Standby switch in the Receive position.
6. Set the Bandspread dial pointer on the Set mark (near 86 on the Log scale).
7. Set the Phasing control with the red dot at the top of the knob.
8. Turn the receiver on by rotating the A.C. Off-Volume control clockwise.
9. Set the Main Tuning dial pointer at the desired frequency. The S meter will show a maximum reading when the signal is exactly tuned in.
10. Adjust the Antenna control for maximum S meter reading.
11. Readjust the Volume control as desired and place the Tone control in the position which is most pleasing to the ear.

Adjustments During Operation

After the receiver has been placed in operation the following adjustments may improve reception of a desired signal:

1. When receiving signals on the broadcast band the Sensitivity control should be adjusted according to the strength of the received signal. For strong local broadcast stations the best position will be 1/2 to 3/4 turn clockwise, while the extreme clockwise position is optimum for reception of weak signals.
2. For voice reception on crowded bands advance the Selectivity switch to positions 1 or 2 to eliminate strong interfering signals. Use the Phasing control to adjust for maximum selectivity.
3. Placing the Reception switch in the ANL position will effectively suppress most types of objectionable noise which might interfere with the signal.

3-5. CODE TELEGRAPHY (CW) RECEPTION

For CW reception the receiver should be placed in operation as described in paragraph 3-4 for voice reception with the following changes:

1. Set the Reception switch at CWO.
2. Set the Sensitivity control at approximately mid-position.
3. Adjust the Pitch control so that the red dot on the knob is at the top center position.
4. Turn the A.C. Off-Volume control to the

extreme clockwise position.

5. Place the Selectivity switch in position 2.
6. Tune the receiver until a "zero beat" with the signal is obtained. As the receiver is tuned to a CW signal a tone of varying pitch is heard, starting with a high note and going down until a position is found where no tone is present. As the receiver is tuned further in the same direction a note will again be heard, varying from a low pitch to a higher. The midpoint of these two notes, or the position which produces no audible tone, is called "zero beat" and it is this point to which the receiver should be tuned.
7. Adjust the Pitch control to that position which provides the most pleasing signal for the operator to copy and set the Sensitivity control for the desired volume.
8. Adjust the Phasing control for minimum interference of the signal.

It will be noted that for CW operation the functions of the Sensitivity and the A.C. Off-Volume controls are interchanged, the latter being left full on, and the Sensitivity control used as the volume control.

3-6. PHONO OPERATION

The NC-98 is equipped with a phono jack (see Figure 1) which will accommodate a standard phono tip plug so that a record player not equipped with an amplifier may be operated through the audio circuits of the receiver. If the record player has other than a standard phono tip plug, the correct fitting can be readily installed. The NC-98 has a high-impedance phono input circuit and is suitable for use with crystal pickups. Variable reluctance type cartridges cannot be used both because their output is too low without an additional amplifier and special compensation is required for correct tonal reproduction.

To connect the phonograph for operation through the receiver, first place the receiver in operation as described in paragraph 3-4 except that the Sensitivity control is set at the extreme counterclockwise position and the Reception switch in the MVC position. Plug the phono tip plug into the phono jack on the receiver and adjust the Off-Volume control for the desired volume. The Off-Volume and Tone controls perform their normal functions during phono operation; all other controls are inoperative.

3-7. NBFM OPERATION

For FM Adapter operation, remove the jumper plug from the accessory socket and plug in the FM Adapter. Set the front panel controls as described in paragraph 3-4 and illustrated in Figure 2, except that the Reception switch must be in the MVC position. Adjustment of controls during FM opera-

tion is the same as described in paragraph 3-4.

3-8. THE CIVIL DEFENSE FREQUENCIES

Recently the Federal Communications Commission authorized the Conelrad frequencies of 640 and 1240 kilocycles for use by broadcast stations in the event the United States declares a war-time emergency. In that event all transmitters will be required by law to immediately cease all operation, with broadcast stations resuming operation on only

those two frequencies. Accordingly, these frequencies have been clearly marked on the A scale of the NC-98 and are identified by circles enclosing the letters, CD. To receive either of these two frequencies place the receiver in operation for the broadcast band and set the Bandspread pointer on the Set mark. Then set the Main Tuning dial pointer in the center of either of the two circles and the receiver will be set up for proper reception of emergency bulletins.

SECTION 4. ALIGNMENT DATA

Realignment of the NC-98 should not be necessary until the receiver has been in use for a considerable length of time, when aging of components may gradually produce a change in individual electrical characteristics and cause the receiver to suffer a loss of sensitivity. Realignment should not be attempted until its need has been definitely established by a check of receiver performance against normal expected performance. In no case must realignment be attempted by any person not thoroughly familiar with communications type of receivers.

In general, realignment of the NC-98 may be divided into two steps:

1. I.F. Alignment
2. R.F. Alignment

Paragraph 4-1 gives the procedure for aligning the intermediate frequency amplifier stages while paragraph 4-2 outlines alignment of the oscillator and mixer stages. See Figures 3 and 4 for location of alignment adjustments.

4-1. I.F. ALIGNMENT

The intermediate frequency of the NC-98 is 455 kilocycles, plus or minus 2 kilocycles. The exact frequency is determined by the crystal, Y-1, used in the crystal filter. The I.F. transformers, crystal filter and CW oscillator transformer all have individual iron core inductors with screw-type adjustments for alignment purposes.

The preliminary alignment procedure is as follows:

1. Connect the output lead of an accurately calibrated signal generator through a 0.1 mfd capacitor to the mixer section of the main tuning capacitor and connect the ground lead to any convenient chassis point.

2. Connect the loudspeaker to the Speaker terminal strip at the rear of the chassis. If no loudspeaker is available connect a 4-ohm resistor across the Speaker terminal strip.

3. Connect an A.C. voltmeter across the loud-

speaker terminals or across the resistor.

4. Set the front panel controls as follows:

Selectivity switch at Off.

Red dot on the Phasing control at the top of the knob.

Sensitivity control in full clockwise position.

Band switch at A.

Reception switch at AVC.

Receive-Standby switch at Receive.

Tone switch at Tone.

A.C. Off-Volume rotated to full clockwise position.

5. Disconnect the antenna from the antenna terminal strip.

6. Adjust the S meter to zero by means of the screw located at the rear of the chassis.

7. Change the front panel controls as follows:

Reception switch to CWO.

Selectivity switch to position 2.

8. Turn the modulation of the signal generator off to provide a CW test signal tuned to approximately 455 kilocycles and adjust the output attenuator to provide a readable signal voltage at the voltmeter.

9. The Pitch control must be set to provide an audible beat note on the loudspeaker or on a pair of headphones temporarily plugged in for this purpose.

10. Tune for the crystal frequency by varying the tuning control of the generator slowly between the frequencies of 453 and 457 kilocycles. At some frequency between these limits the A.C. voltmeter will show a very sharply peaked response. If this response cannot be found retard the Sensitivity control or decrease the output of the signal generator to remove possible overload. The frequency which produces the sharp response is that of the crystal, and I.F. alignment as described in the following steps, is made at this frequency.

11. Change the Reception switch to AVC and the Selectivity switch to Off.

12. Turn the modulation of the signal generator

On. Adjust the output of the signal generator and the volume control of the receiver for a suitable deflection of the voltmeter.

13. Using the proper aligning tool, adjust first the secondary and then the primary of Z-3 for maximum deflection of the meter.

14. In the same manner, tune Z-2 and Z-1 for maximum indication on the output meter.

15. Repeat the above procedure making sure that all adjustments have been correctly made.

16. Set the Selectivity switch at position 1.

17. Tune the signal generator two kilocycles higher than the crystal frequency previously determined.

18. Adjust L-14 for a maximum reading on the A.C. voltmeter.

4-2. R.F. ALIGNMENT

The first step in aligning the R.F. section of the NC-98 is to determine whether or not the receiver calibration is correct and, if found to be incorrect, whether it is a mechanical or electrical error. Incorrect mechanical calibration is evidenced by the frequency readings being off a certain equal

linear amount on all bands, while incorrect electrical calibration produces readings which are off on one band only or a different amount on each band.

To effect mechanical correction of calibration of the main tuning dial, set the rotors of the main tuning capacitor flush with the stators. Hold the Main Tuning control with one hand to keep the capacitor from moving, and set the pointer at the first marker on the C scale (just to the left of 4.7 mc). The procedure for mechanical correction of bandspread calibration is the same except that correction is made with the bandspread capacitor and pointer. The correct pointer setting is at zero on the log scale.

Table 4-1 gives, in proper order, the adjustments to be made for alignment of the oscillator and mixer stages of the NC-98. For all of these adjustments the modulated output of a signal generator is connected to the antenna input terminals through a standard dummy antenna of 300 ohms and the A.C. voltmeter connected across the loudspeaker terminals. On the A, B and C bands the oscillator operates on the high side, the D band operates on the low side.

TABLE 4-1. ALIGNMENT DATA

Step	Band	Adjust Signal Source to:	Set Main Tuning Dial at:	Set Bandspread Dial at:	Adjust to Receive Test Signal:	Adjust for Maximum Output
1	A	1.6 mc.	1.6 mc.	Set	C-39	C-9
2	A	0.6 mc.	0.6 mc.	Set	L-5	
3	A	Repeat steps 1 and 2				
4	B	4.0 mc.	4.0 mc.	Set	C-40	C-10
5	B	1.6 mc.	1.6 mc.	Set	L-6	
6	B	Repeat steps 4 and 5				
7	C	14.0 mc.	14.0 mc.	Set	C-41*	C-11**
8	C	5.0 mc.	5.0 mc.	Set	L-7	
9	C	Repeat steps 7 and 8				
10	D	30.0 mc.	30.0 mc.	Set	C-42**	C-12*
11	D	15.0 mc.	15.0 mc.	Set	L-8***	
12	D	Repeat steps 10 and 11				

* If signal is found at two settings of capacitor use setting closest to minimum capacity.

** If signal is found at two settings of capacitor use setting closest to maximum capacity.

*** To set L-8, unscrew the slug as far as possible. The second signal obtained while screwing the slug back in is the correct one.

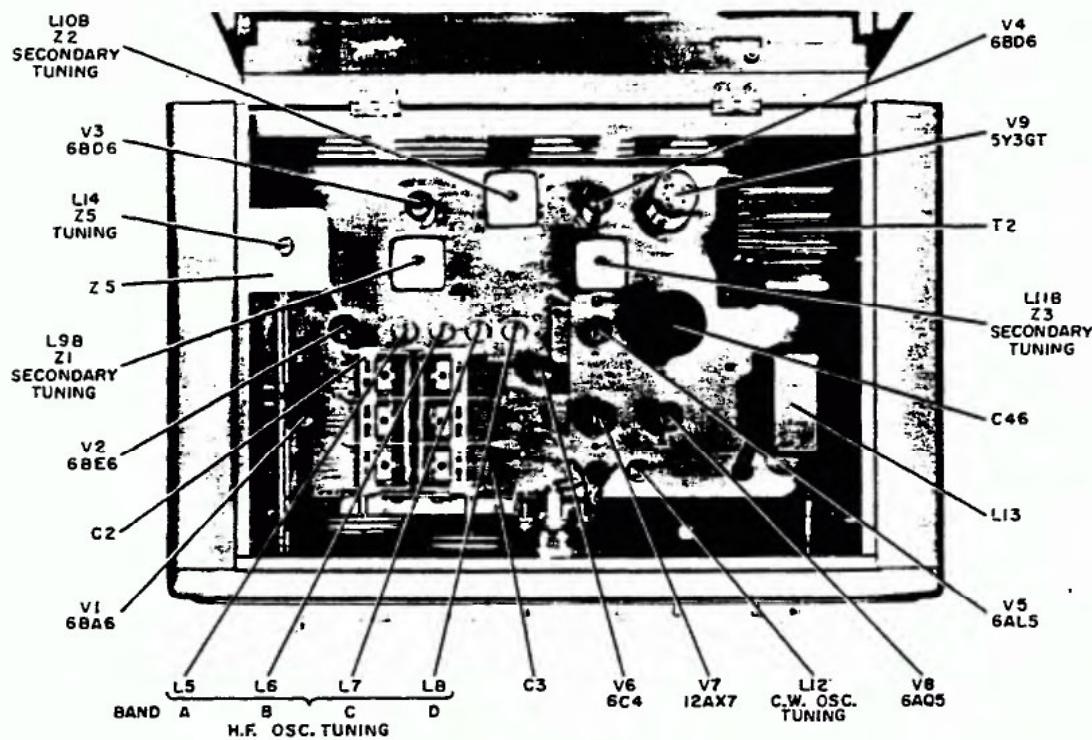


Figure 3. Component Locations, Top View of Receiver

4-3. VOLTAGE DATA

The voltage measurements on Figure 5 will facilitate any servicing which might be required on the NC-98. The readings were taken using a high impedance vacuum-tube voltmeter. Except where otherwise noted, all voltages are D.C. and obtained with an input voltage of 115 VAC to the receiver. The following control settings must be observed when taking voltage measurements:

Sensitivity	Extreme clockwise position
Receive-Standby	Set to Receive
Band	Set to band A
Tone	Set at Tone
Reception	Set at CW
A.C. Off-Volume	Extreme clockwise position
Bandspread	Place on Set mark
Main Tuning	Set to 700 kilocycles

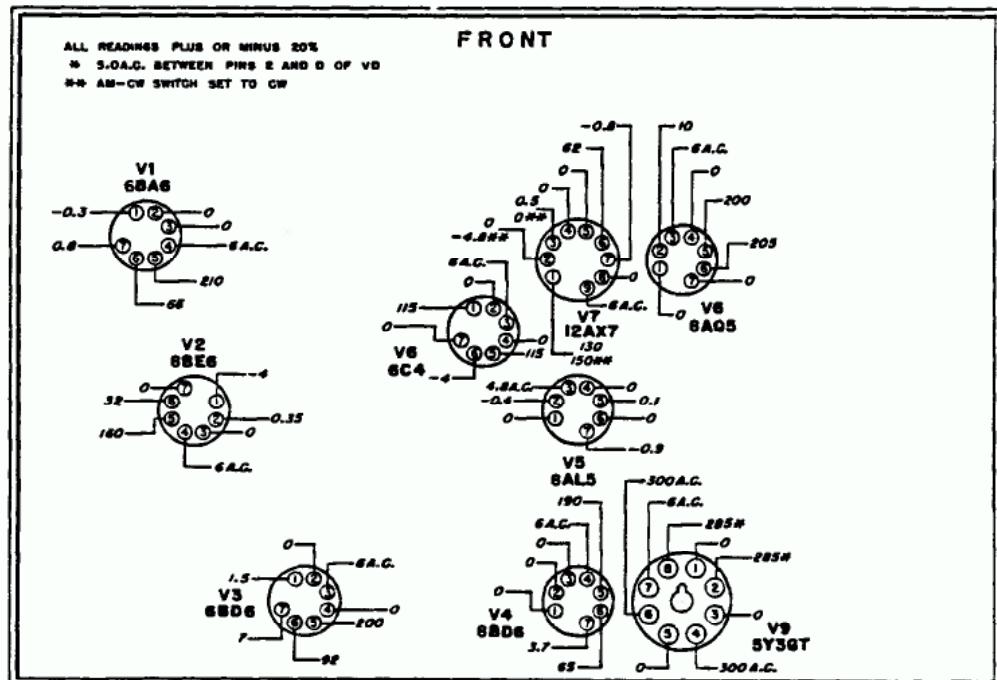


Figure 5. Tube Socket-to-Chassis Voltage Measurements

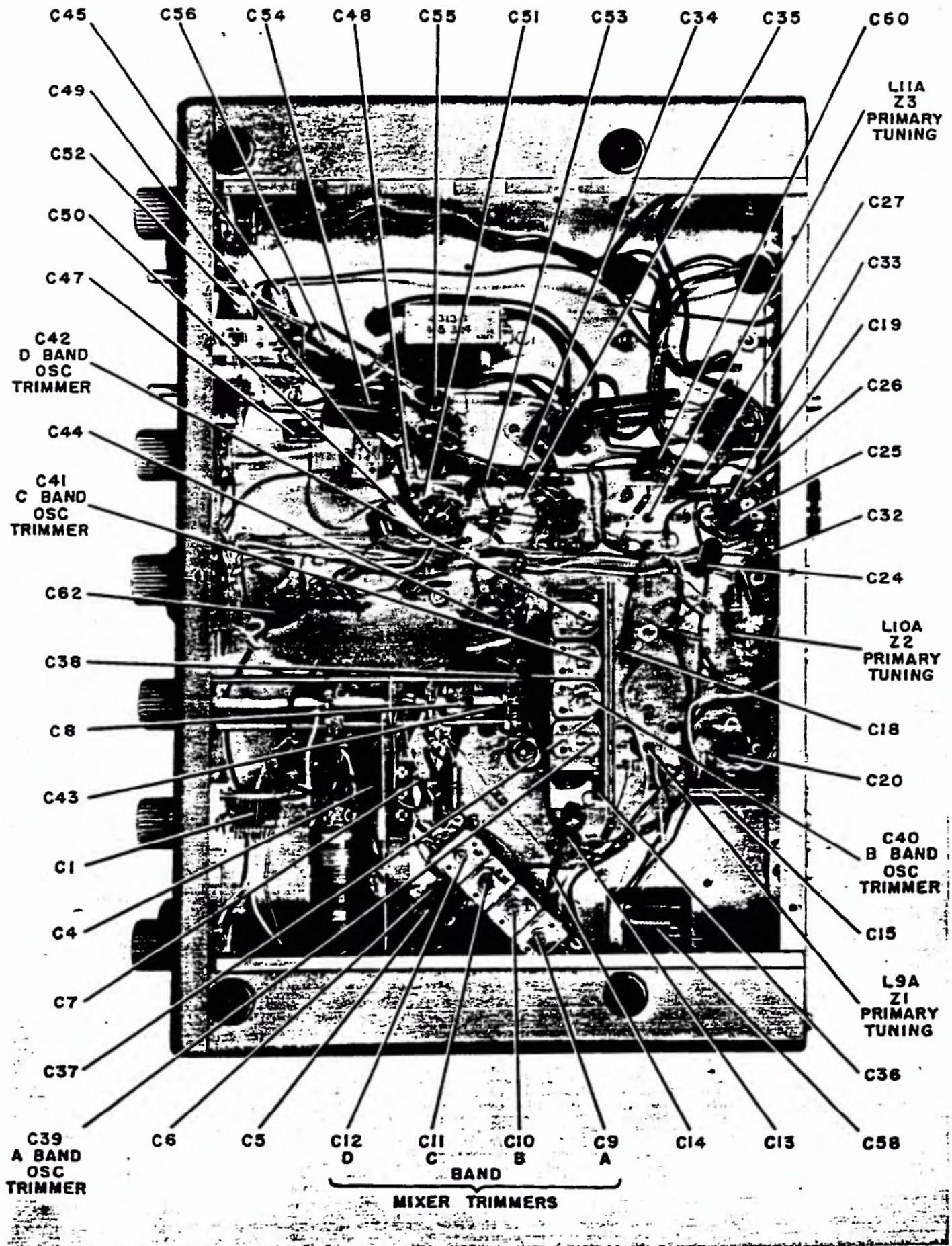


Figure 4. Capacitor and Alignment Adjustment Locations, Bottom View of Receiver

4-4. DIAL STRINGING

Should the dial string mechanism require repair refer to Figure 6.

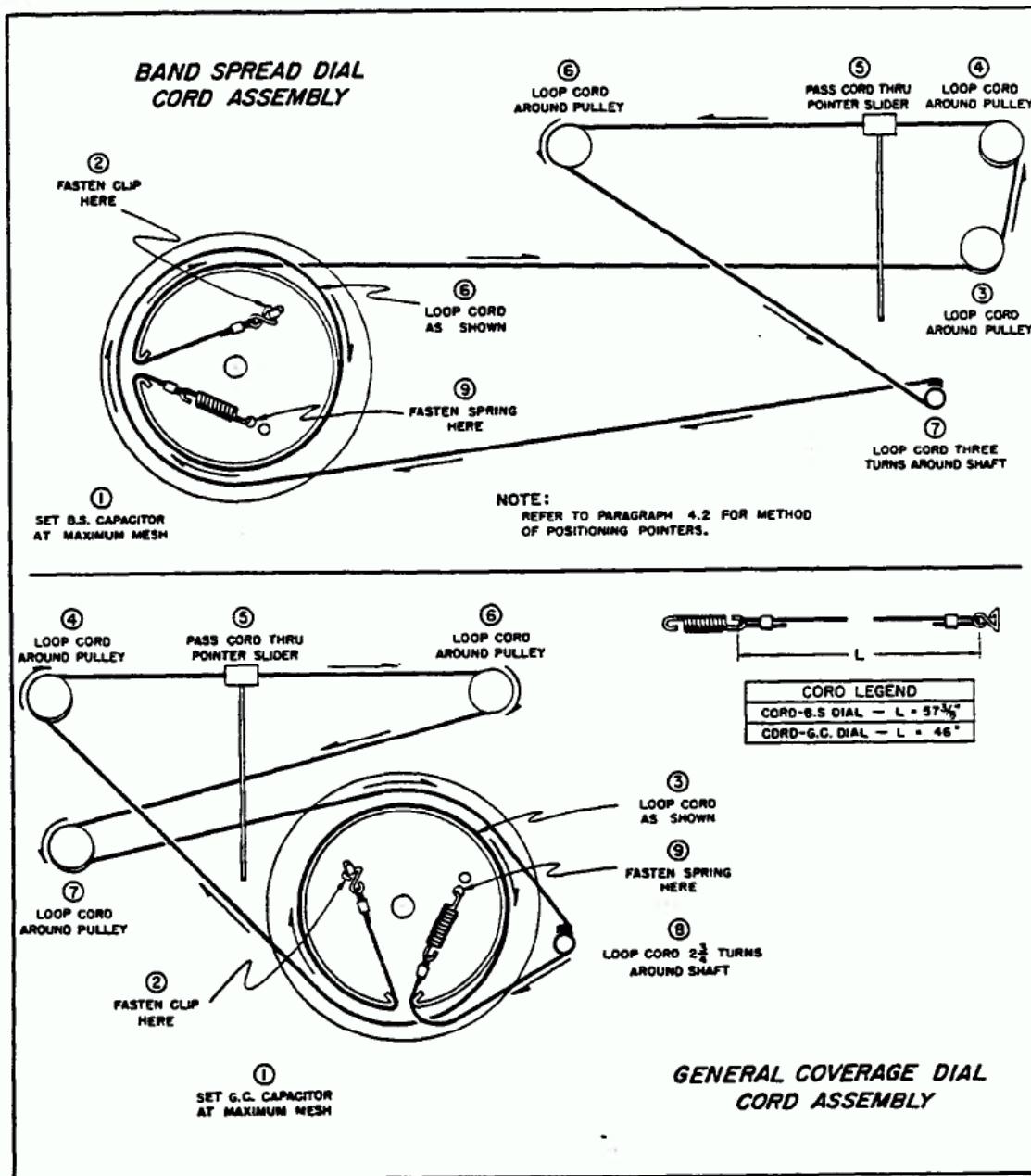


Figure 6. Dial Cord Stringing Guide

Standard Form Warranty

Adopted by the Radio Manufacturers Association, Inc.

This equipment is warranted to be free from defective material and workmanship and repair or replacement will be made of any part which under normal installation, use and service discloses defect, provided the unit is delivered by the owner to the manufacturer or through the authorized radio dealer or wholesaler from whom purchased, intact, for examination, with all transportation charges prepaid to the factory, within ninety days from the date of sale to original purchaser, and provided that such examination discloses in the manufacturer's judgment that it is thus defective.

This warranty does not extend to any radio products which have been subjected to misuse, neglect, accident, incorrect wiring, improper installation, or to use in violation of instructions furnished by the manufacturer, nor extend to units which have been repaired or altered outside of the factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith of other manufacture.

Any part of a unit approved for remedy or exchange hereunder will be remedied or exchanged by the authorized radio dealer or wholesaler without charge to the owner.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for the manufacturer any other liability in connection with the sale of their radio products.

National Company, Inc. reserves the right to make any change in design or to make addition to, or improvements in, its products without imposing any obligations upon itself to install them in its products previously manufactured.

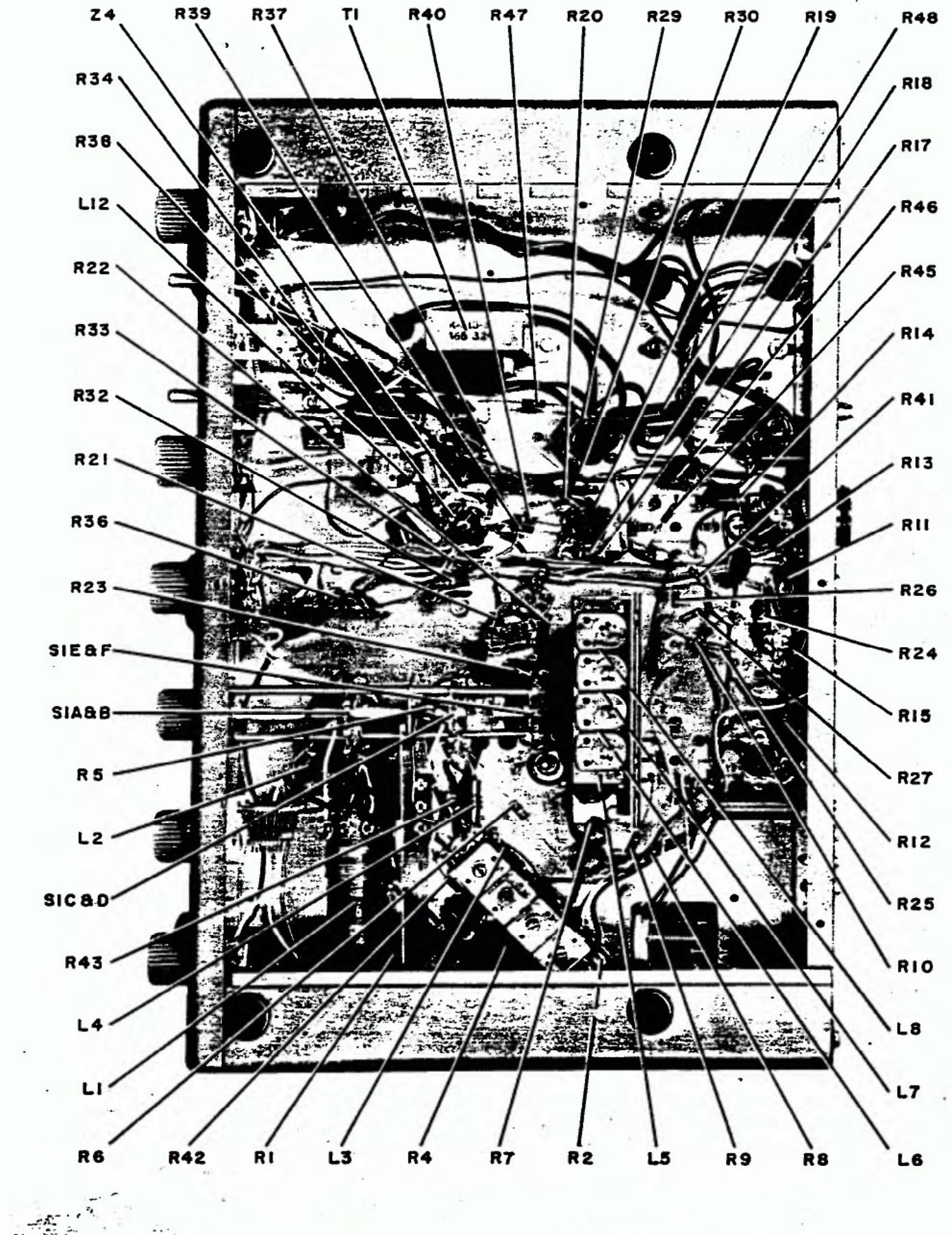


Figure 7. Resistor and Miscellaneous Component Locations, Bottom View of Receiver

PARTS LIST

Symbol	Description	Nat. Co. Type
CAPACITORS		
C1	Air Variable, 5-50 mmf	S662-1
C2	Air Variable, 3-sections, 10-37 mmf per section	C10275
C2A	Part of C2	
C2B	Part of C2	
C2C	Part of C2	
C3	Air Variable, 3-sections, 13-454 mmf per section	C10274
C3A	Part of C3	
C3B	Part of C3	
C3C	Part of C3	
C4	Mica, 220 mmf	J665-44
C5	Ceramic, disc type, 0.01 mf	K946-2
C6	Ceramic, disc type, 0.01 mf	K946-2
C7	Ceramic, disc type, 0.01 mf	K946-2
C8	Mica, 510 mmf	J665-57
C9	Variable mica, 2.2-4 mmf	D832-5
C10	Variable mica, 2.2-4 mmf	D832-5
C11	Variable mica, 2.2-4 mmf	D832-5
C12	Variable mica, 2.2-4 mmf	D832-5
C13	Ceramic, disc type, 0.01 mf	K946-2
C14	Ceramic, disc type, 0.01 mf	K946-2
C15	Paper, 0.1 mf, 400 v	Q693-34
C16	87 mmf; part of Z1	
C17	87 mmf; part of Z1	
C18	Ceramic, disc type, 0.01 mf	K946-2
C19	Paper, 0.1 mf, 400 v	Q693-34
C20	Ceramic, disc type, 0.01 mf	K946-2
C21	Not used	
C22	87 mmf, part of Z2	
C23	87 mmf, part of Z2	
C24	Ceramic, disc type, 0.01 mf	K946-2
C25	Paper, 0.01 mf, 400 v	Q693-19
C26	Ceramic, disc type, 0.01 mf	K946-2
C27	Ceramic, disc type, 0.01 mf	K946-2
C28	110 mmf, part of Z3	
C29	110 mmf, part of Z3	
C30	100 mmf, part of Z3	
C31	100 mmf, part of Z3	
C32	Paper, 0.01 mf, 400 v	Q693-19
C33	Ceramic, 10 mmf	J695-2
C34	Ceramic, disc type, 0.01 mf	K946-2
C35	Ceramic, 3 mmf	J695-4
C36	Mica, 470 mmf $\pm 5\%$	J665-55
C37	Mica, 0.001 mf $\pm 5\%$	J665-70
C38	Mica, 0.003 mf	J666-30
C39	Variable ceramic, 5-20 mmf	E311-2
C40	Variable ceramic, 5-20 mmf	E311-2
C41	Variable ceramic, 2.5-6 mmf	E311-1
C42	Variable ceramic, 5-20 mmf	E311-2
C43	Mica, 220 mmf	J665-44

Symbol	Description	Nat. Co. Type
C44	Mica, 0.001 mf	J666-14
C45	Paper, 0.047 mf, 400 v	Q693-28
C46	3-section, 20 mf per section $\pm 20\%$, 450 v	H235-2
C46A	Part of C46	
C46B	Part of C46	
C46C	Part of C46	
C47	Mica, 180 mmf	J665-41
C48	Paper, 0.01 mf, 400 v	Q693-19
C49	Mica, 220 mmf	J665-44
C50	Mica, 270 mmf	J665-47
C51	Ceramic, 47 mmf	D825D-447
C52	Paper, 0.01 mf, 400 v	Q693-19
C53	Ceramic, disc type, 0.01 mf	K946-2
C54	Electrolytic, 25 mf, 50 v	E338-4
C55	Ceramic, disc type, 0.01 mf	K946-2
C56	Paper, 0.047 mf, 400 v	Q693-28
C57	Ceramic, 21 mmf, part of Z5	D825D-410
C58	Air Variable, 5-50 mmf; part of Z5	S662-1
C59	Mica, 100 mmf; part of Z5	J665-32
C60	Ceramic, disc type 0.01 mf	K946-2
C61	Ceramic, 2 mmf	F912-3
C62	Ceramic, disc type, 0.01 mf	K946-2

All capacitors are fixed, $\pm 10\%$ tolerance, 500 volts working except where noted otherwise.

RESISTORS		
R1	Fixed, 470,000 ohms	J569-57
R2	Fixed, 68 ohms	J569-11
R3	Variable, wire wound, 10,000 ohms; 2 watts	K349-3
R4	Fixed, 47,000 ohms	J569-45
R5	Fixed, 15,000 ohms, 1 watt	J571-39
R6	Fixed, 33 ohms	J569-7
R7	Fixed, 220 ohms	J569-17
R8	Fixed, 150,000 ohms	J569-51
R9	Fixed, 220 ohms	J569-17
R10	Fixed, 270,000 ohms	J569-54
R11	Fixed, 680 ohms	J569-23
R12	Fixed, 100,000 ohms	J569-49
R13	Fixed, 1,000 ohms	J569-25
R14	Fixed, 100,000 ohms	J569-49
R15	Fixed, 2,200 ohms	J569-29
R16	Fixed, 47,000 ohms	J569-45
R17	Fixed, 270,000 ohms	J569-54
R18	Fixed, 270,000 ohms	J569-54
R19	Fixed, 1 megohm	J569-61
R20	Fixed, 1 megohm	J569-61
R21	Fixed, 15,000 ohms, 1 watt	J571-39
R22	Fixed, 150 ohms	J569-15
R23	Fixed, 47,000 ohms	J569-45
R24	Fixed, 100,000 ohms, 1 watt	J571-49

PARTS LIST (CONT'D)

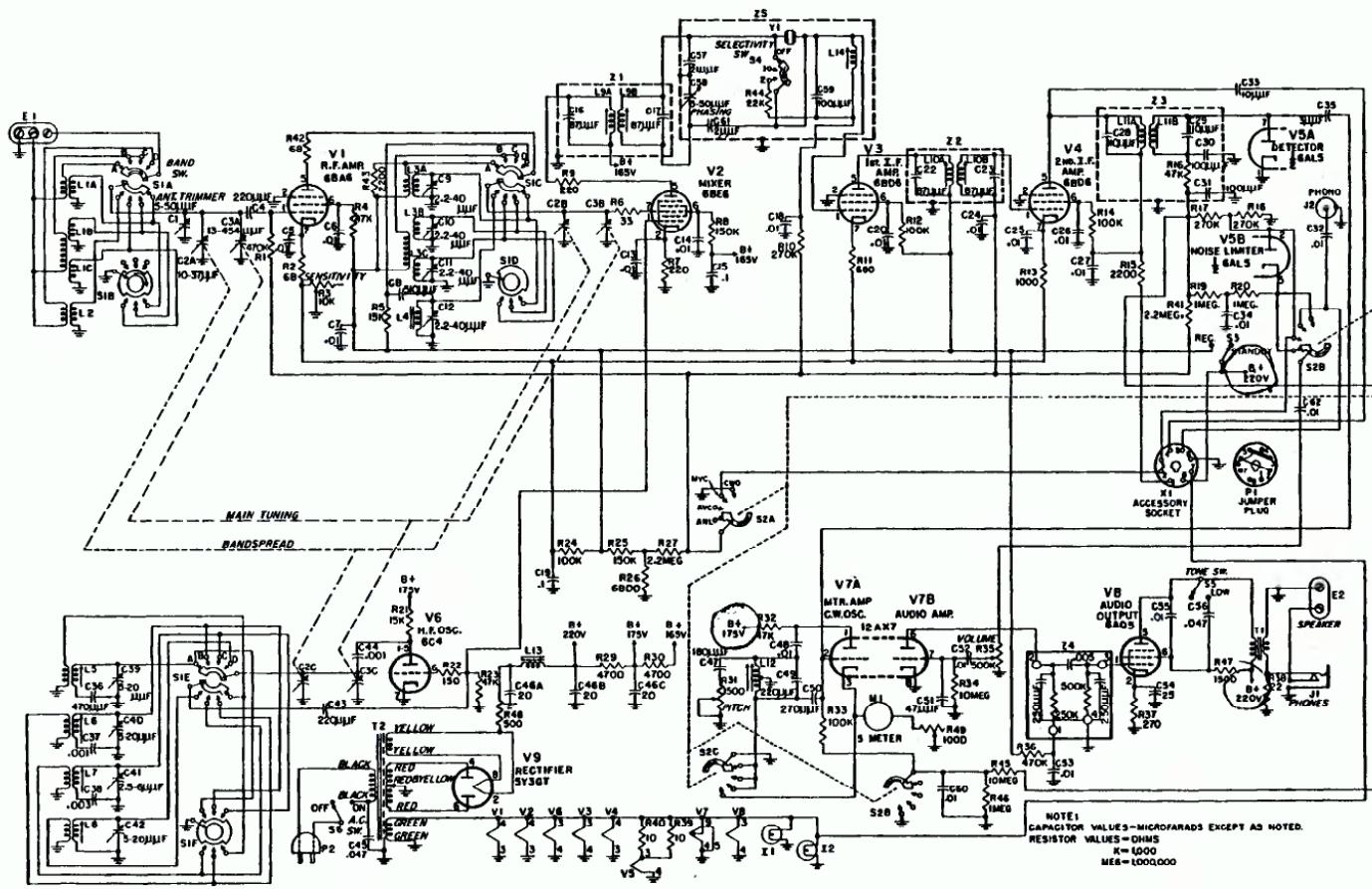
Symbol	Description	Nat. Co. Type
R25	Fixed, 150,000 ohms	J569-51
R26	Fixed, 6,800 ohms	J569-35
R27	Fixed, 2.2 megohms	J569-65
R28	Not used	
R29	Fixed, 4,700 ohms, 2 watts	J572-33
R30	Fixed, 4,700 ohms	J569-33
R31	Variable, 1,500 ohms	K915-16
R32	Fixed, 47,000 ohms, 1 watt	J571-45
R33	Fixed, 100,000 ohms	J569-49
R34	Fixed, 10 megohms	J569-73
R35	Variable, 500,000 ohms; with SPST switch	K347-1
R36	Fixed, 470,000 ohms	J569-57
R37	Fixed, 270 ohms, 1 watt	J571-18
R38	Fixed, 22 ohms, 1 watt	J571-5
R39	Fixed, 10 ohms	J569-1
R40	Fixed, 10 ohms	J569-1
R41	Fixed, 2.2 megohms	J569-65
R42	Fixed, 68 ohms	J569-11
R43	Fixed, 2,200 ohms	J569-29
R44	Fixed, 22,000 ohms	J569-41
R45	Fixed, 10 megohms	J569-73
R46	Fixed, 1 meghm	J569-61
R47	Fixed, 1,500 ohms	J569-27
R48	Fixed, 500 ohms, 10 watts	M707-3
R49	Variable, 1,000 ohms, 1 watt	D831-2

±10% tolerance, 1/2 watt power rating on all resistors unless otherwise noted

MISCELLANEOUS		
E1	Antenna terminal strip	E261-3
E2	Speaker terminal strip	E265-8
E3	Knobs, large (2 used)	SA:5292-2
E4	Knobs, small (7) used	SA:9305
E5	Knob (1 used)	SB:2644
I1	Dial lamp, type 47	F136-11
I2	Meter lamp, type 47	F136-11
J1	Headphone jack	K314-2
J2	Phono jack	T458-1
L1	R.F. coil, bands A, B, C	SB:1517
L2	R.F. coil, band D	SB:1519
L3	Mixer coil, bands A, B, C	SB:1518
L4	Mixer coil, band D	SB:1520
L5	Variable iron core, band A oscillator coil	SB:1573-1
L6	Variable iron core, band B oscillator coil	SB:1574-1
L7	Variable iron core, band C oscillator coil	SB:1575-1
L8	Variable iron core, band D oscillator coil	SB:1576-1

Symbol	Description	Nat. Co. Type
L9A	Inductor, variable iron core, Z1 primary	Part of Z1
L9B	Inductor, variable iron core, Z1 secondary	Part of Z1
L10A	Inductor, variable iron core, Z2 primary	Part of Z2
L10B	Inductor, variable iron core, Z2 secondary	Part of Z2
L11A	Inductor, variable iron core, Z3 primary	Part of Z3
L11B	Inductor, variable iron core, Z3 secondary	Part of Z3
L12	BFO coil	SB:2642
	Iron core for L12	D166-5
L13	Filter Choke	K317-1
L14	Crystal Filter coil, part of Z5	SB:2641
	Iron core for L14	K911-1
M1	S-Meter, 0-1 ma, illuminated	T366-1
P1	A.C. line cord and plug, 2 wire	E544-1
S1	3-deck, 6 section rotary switch	S245-1
S2	Rotary switch, 4 pole, 4 position	T364-1
S3	Toggle switch, SPST	E230-2
S4	Rotary switch, 1 pole, 3 position	T365-1
S5	Toggle switch, SPST	E230-2
S6	A.C. switch	Part of R35
T1	Audio output transformer, 5,000 ohms primary to 3.2 ohms secondary	K313-3
T2	Power transformer, 105/130 volts, 50/60 cycles AC primary; secondary 300-0-300 vac at 100 ma, 5 vac at 2.0 amp and 6.3 vac at 3.0 amp	K316-5
V1	Tube, type 6BA6	
V2	Tube, type 6BE6	
V3	Tube, type 6BD6	
V4	Tube, type 6BD6	
V5	Tube, type 6AL5	
V6	Tube, type 6C4	
V7	Tube, type 12AX7	
V8	Tube, type 6AQ5	
V9	Tube, type 5Y3GT	
Y1	Crystal, 455 kc, part of Z5	E979-1
Z1	1st I.F. transformer, 455 kc	Q242-2
Z2	2nd I.F. transformer, 455 kc	Q242-2
Z3	Detector input transformer	Q242-1
Z4	Printed circuit, type PC-71	R983-1
Z5	Crystal filter unit	SB:2636

Figure 3. Schematic Diagram



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ER-432

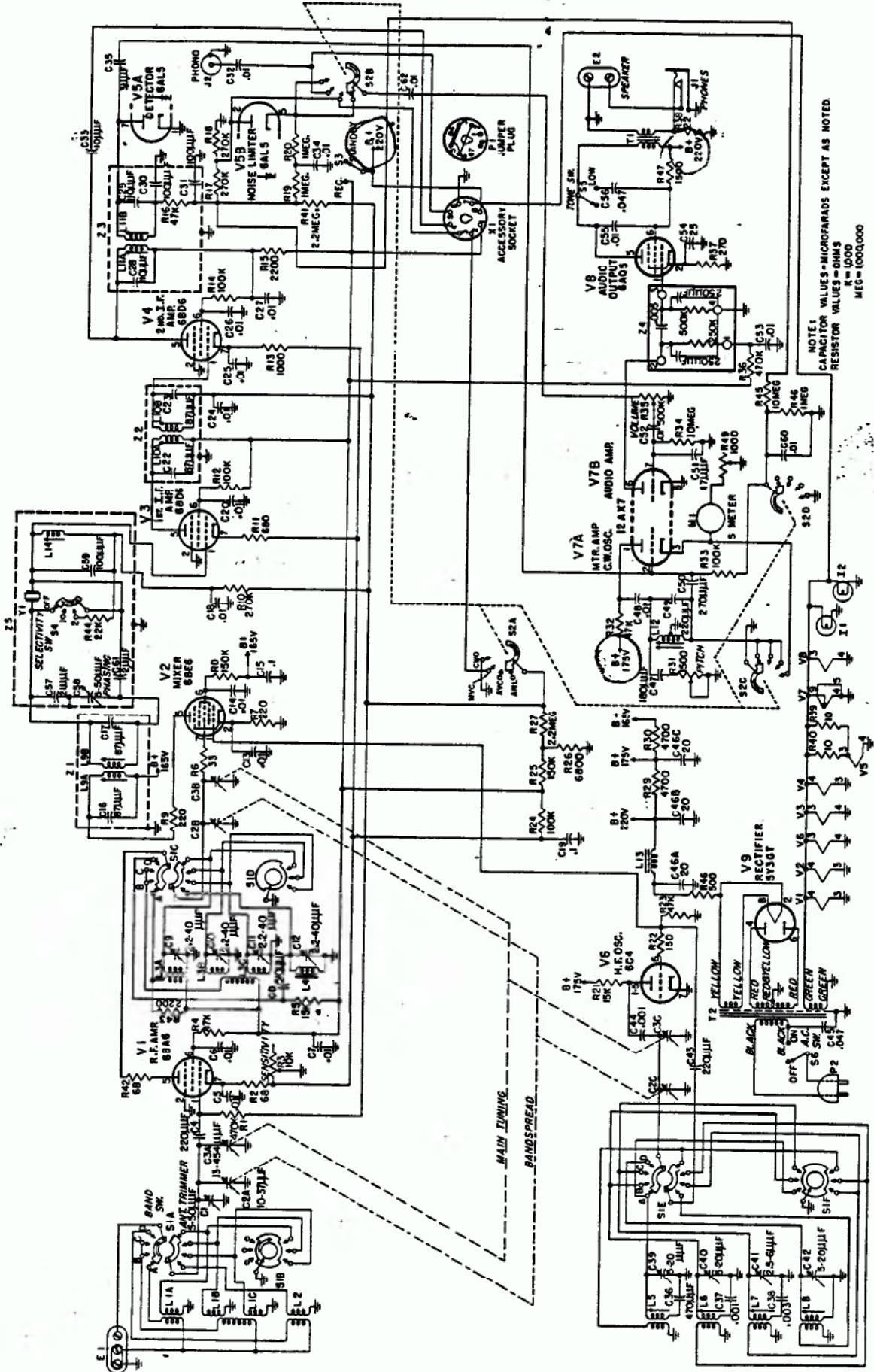
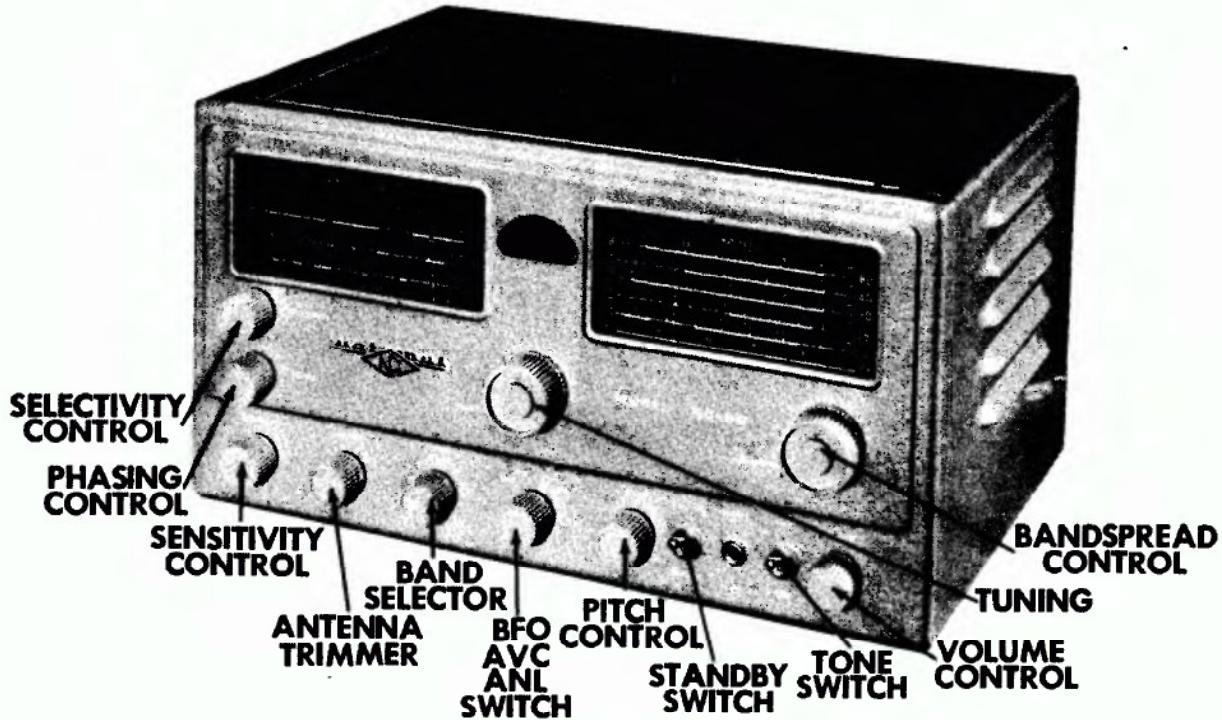


Figure 8. Schematic Diagram

2500-355-RS

Printed in U.S.A.

ER:432



TRADE NAME National Model NC-98

MANUFACTURER National Co., Inc., 61 Sherman St., Malden 48, Mass.

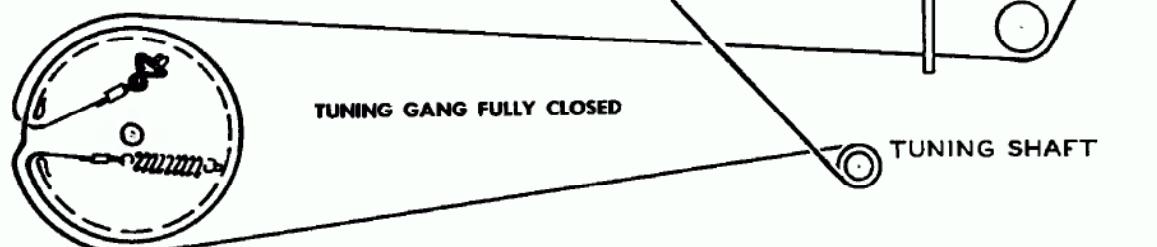
TYPE SET AC Operated Multi-Band Superheterodyne Communications Receiver

TUBES Nine

POWER SUPPLY 105-130 Volts AC - 50/60 Cycles RATING .6 Amp. @ 117 Volts AC

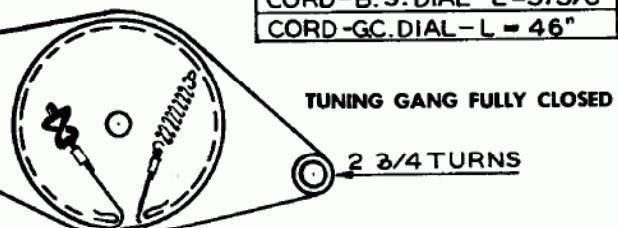
TUNING RANGE	Band "A" 540-1600KC	Band "C" 4.7 -14MC
	Band "B" 1.6 - 4.7MC	Band "D" 14 - 40MC

BAND SPREAD DIAL CORD ASSEMBLY



CORD LEGEND
CORD-B. S. DIAL-L = 573/8"
CORD-GC.DIAL-L = 46"

GENERAL COVERAGE DIAL CORD ASSEMBLY



TUNING GANG FULLY CLOSED

2 3/4 TURNS

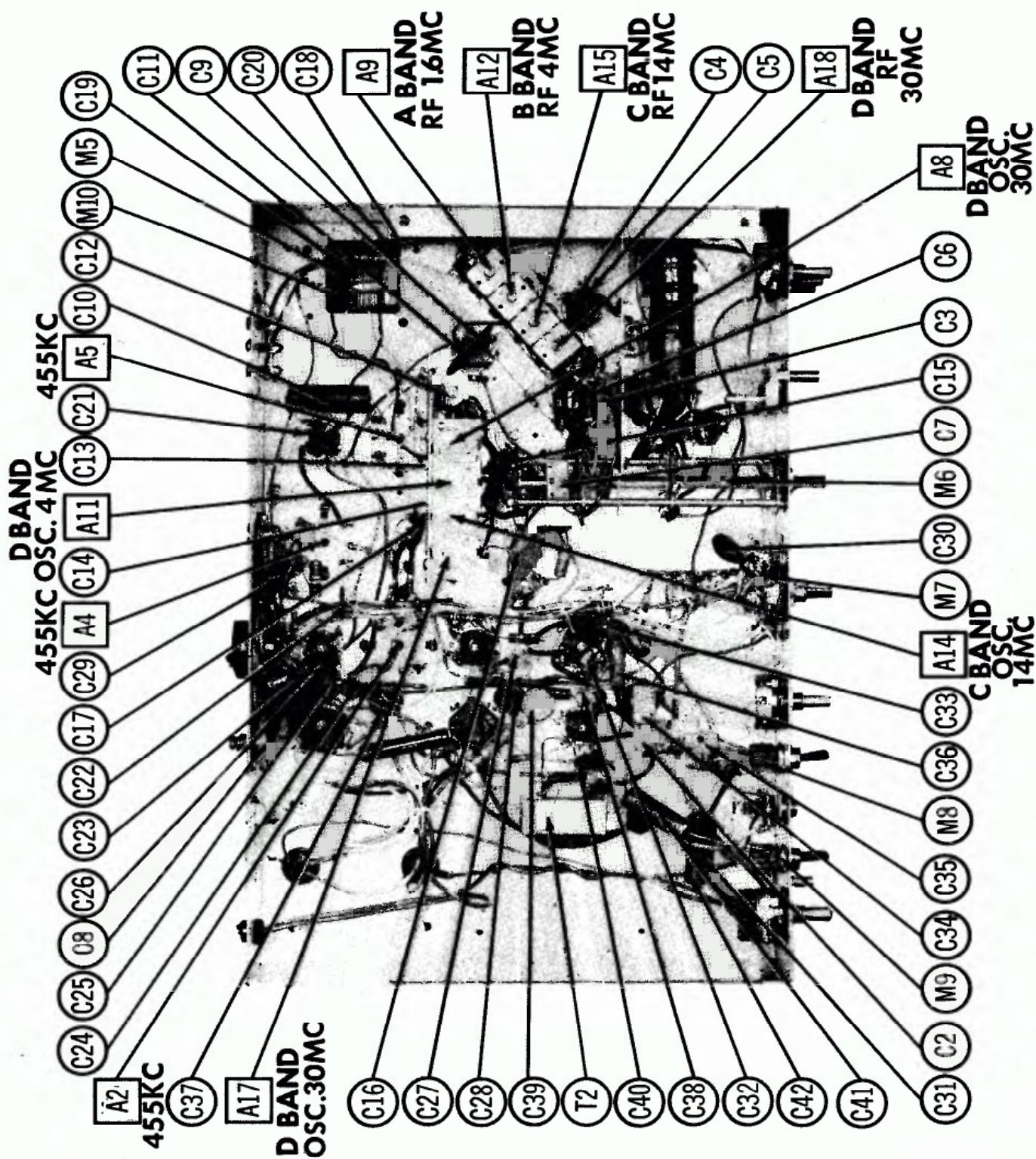
DIAL CORD STRINGING

HOWARD W. SAMS & CO., INC. • Indianapolis 5, Indiana

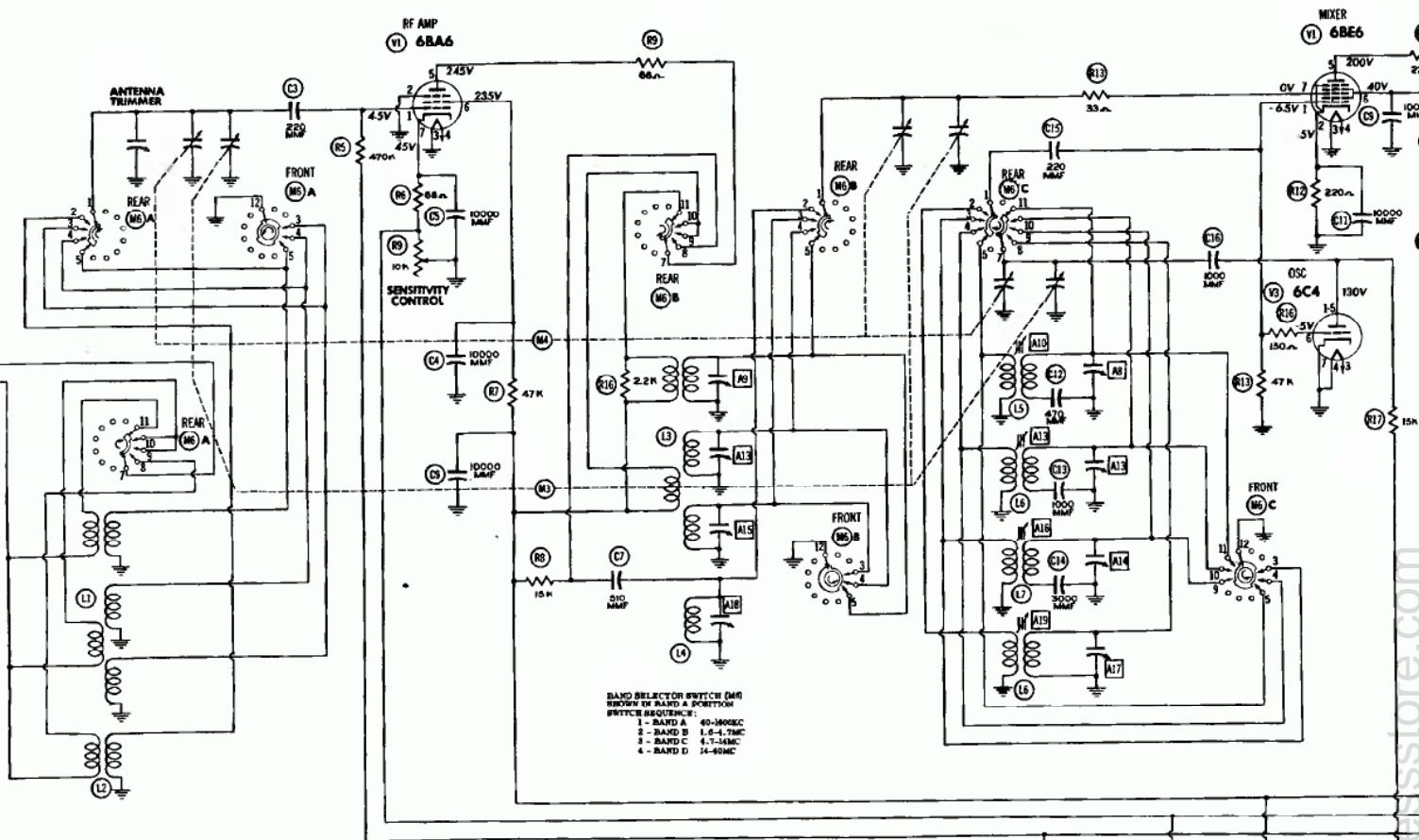
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CHASSIS BOTTOM VIEW-CAPACITOR IDENTIFICATION

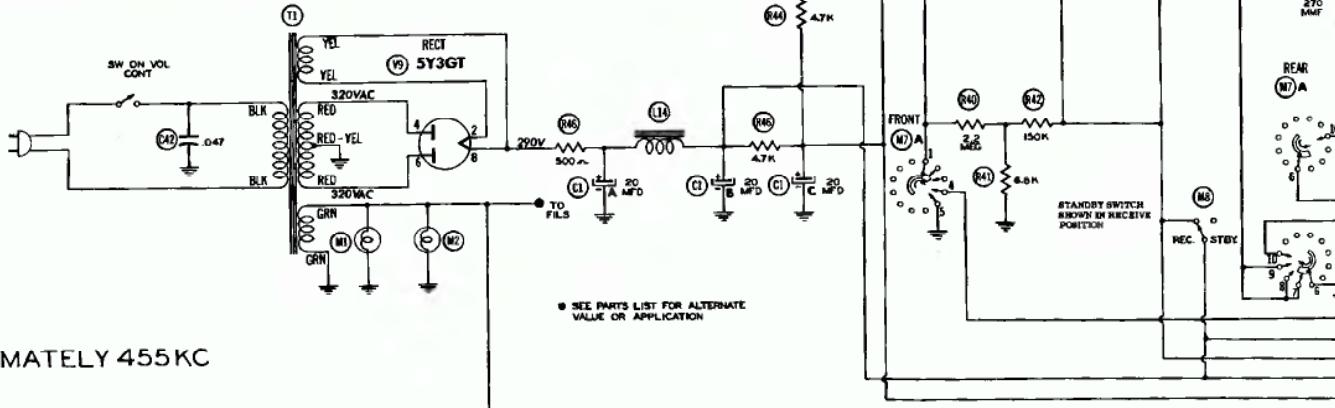


RESISTANCE READINGS										
Item	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V 1	6BA6	1.8Meg	2Ω	0Ω	.1Ω	1A15KΩ 1800Ω	148KΩ	10KΩ		
V 2	6BE6	47KΩ	220Ω	0Ω	.1Ω	110KΩ	1180KΩ	33Ω		
V 3	6C4	120KΩ	INF	.1Ω	0Ω	120KΩ	47KΩ	0Ω		
V 4	6BD6	1.8Meg	0Ω	.1Ω	0Ω	1800Ω	1100KΩ	11KΩ		
V 5	6BD6	1.3Meg	0Ω	0Ω	.1Ω	1800Ω	1100KΩ	11KΩ		
V 6	6AL5	0Ω	270KΩ	.1Ω	0Ω	2.8Meg	0Ω	500KΩ		
V 7	12AX7	150KΩ	1Meg	100Ω	0Ω	0Ω	1720KΩ	10Meg	0Ω	.1Ω
V 8	6AQ5	500KΩ	270Ω	.1Ω	0Ω	110KΩ	12.3KΩ	500KΩ		
V 9	5Y3GT	INF	70KΩ	INF	61Ω	INF	58Ω	.1Ω	70KΩ	

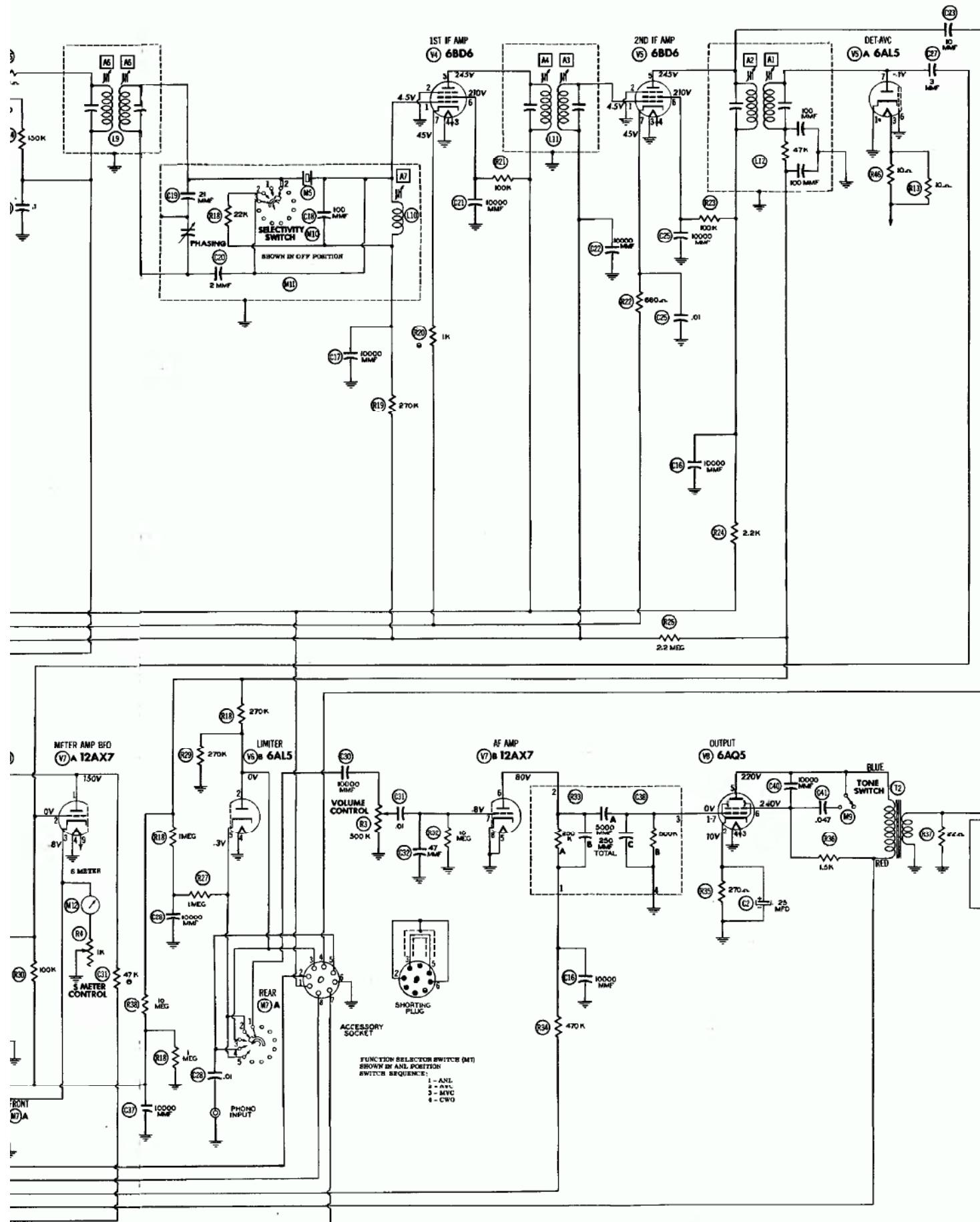
ALL MEASUREMENTS TAKEN WITH BAND SWITCH IN BAND "A" POSITION, RECEPTION SWITCH IN "ANL" POSITION, SELECTIVITY SWITCH IN "OFF" POSITION, SENSITIVITY CONTROL IN MAXIMUM COUNTER CLOCKWISE POSITION, AND RECEIVE STANDBY SWITCH IN "RECEIVE" POSITION.

† MEASURED FROM PIN 2 OF V1.

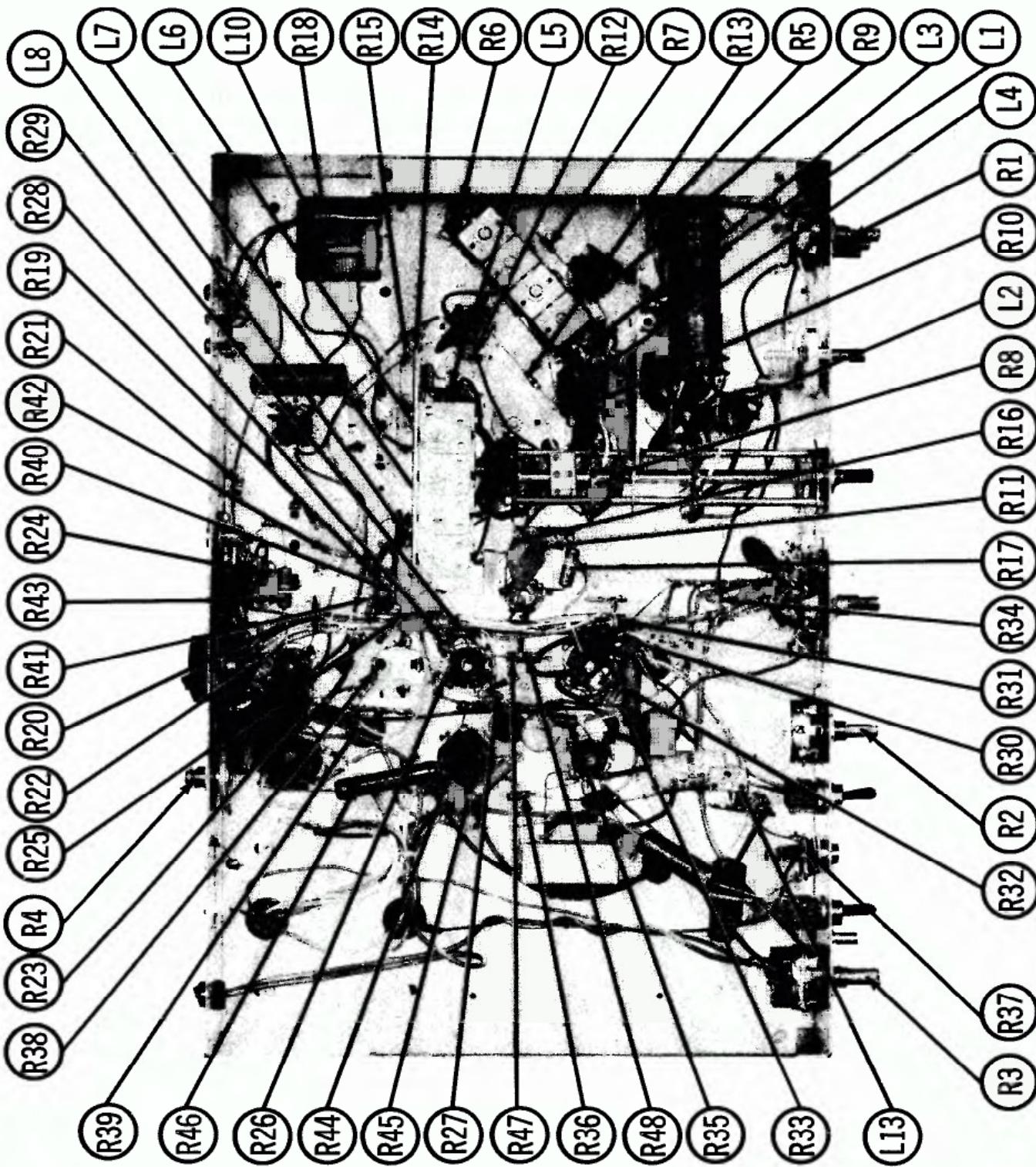
▲ MEASURED WITH BAND SWITCH IN BAND "D" POSITION.



IF=APPROXIMATELY 455 KC



1. DC voltage measurements taken with vacuum tube voltmeter.
 AC voltages measured at 1000 ohms per volt.
 2. Socket connections are shown as bottom view.
 3. Meter readings are given with ground pin to common negative.
 4. Line voltage maintained at 117 volts for voltage readings.
 5. Nominal tolerance on component values makes possible a variation of ± 10% in voltage and resistance readings.
 6. Volume control at maximum, no signal applied for voltage measurements.



CHASSIS BOTTOM VIEW-RESISTOR IDENTIFICATION

ALIGNMENT INSTRUCTIONS

ALIGNMENT INSTRUCTIONS—READ CAREFULLY BEFORE ATTEMPTING ALIGNMENT

Only qualified technicians thoroughly familiar with communications type receivers should attempt alignment of this receiver. Alignment should not be attempted until a thorough check of receiver performance against normal performance has been made.
 With main tuning gang fully closed, slide dial pointer to coincide with the last low frequency mark on the "C" scale. With the band spread tuning capacitor fully closed, set band spread dial pointer to coincide with the "O" index mark on the log scale.
 Allow a 15 minute warm-up period for receiver and test equipment.
 Volume control should be at maximum position. Output of signal generator should be no higher than necessary to obtain an output reading. Use an insulated alignment screwdriver for adjusting.

IF ALIGNMENT

The IF frequency is 455KC ±2KC. The crystal used in the crystal filter determines the exact IF frequency.
 Connect speaker (or 4Ω resistor) across speaker terminals on rear chassis apron.

Pre-set the front panel controls as follows:

- a. Switch selectivity to "Off" position.
- b. Adjust phasing control so that red dot is at top of knob.
- c. Turn sensitivity control maximum clockwise.
- d. Turn reception switch to "AVC" position.
- e. Place "Receive-standby" switch in "Receive" position.
- f. Turn the AC - "Off-Volume" control fully clockwise.
- g. Remove the antenna from the antenna terminals and turn the "Meter Adjust" control (rear chassis apron) until the "S" meter (front panel) reads zero.
- h. Switch the reception switch from position in Step d-to "CWO".
- i. Change the selectivity switch from position in Step a. to position 2.

DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	BAND SWITCH POS.	RADIO DIAL SETTING	OUTPUT METER	ADJUST	REMARKS
1. IMF D	High side to mixer stator lug (mid-section) on main tuning gang. Low side to chassis.	Approx. 455KC (Unmod)	"A"	Tuning gang fully open	Across speaker terminals (rear chassis apron)		Adjust pitch control for audible beat in speaker. Slowly vary signal generator between 453 and 457KC until output meter shows a very sharply peaked response. It may be necessary to back off the sensitivity control or attenuate the signal generator output to obtain this peak. The peak indicates the frequency of the crystal and IF alignment should be made at this frequency.
2. "	"	Exact frequency determined in step 1 (400Mod)	"	"	"	A1, A2, A3, A4 A5, A6	Turn "Reception" switch to "AVC" and "Selectivity" switch to "Off". Adjust in order given until maximum output is obtained.
3. "	"	Tune 2KC higher than frequency determined in step 1.	"	"	"	A7	Change selectivity switch to position 1. Adjust for maximum output.

RF ALIGNMENT

The oscillator operates on the high side on the "A", "B" and "C" bands and on the low side on the "D" band.
 Place the band spread dial pointer at "Set" on the log scale.

DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	BAND SWITCH POS.	RADIO DIAL SETTING	OUTPUT METER	ADJUST	REMARKS
4. 300Ω carbon resistor	High side thru 300Ω to ungrounded antenna terminal. Low side to chassis.	1.6MC (400Mod)	A	1.6MC	Across speaker terminals	A8, A9	Adjust in order given for maximum output.
5. "	"	0.6MC	"	0.6MC	"	A10	Adjust for maximum output. Repeat steps 4 and 5.
6. "	"	4.0MC	B	4.0MC	"	A11, A12	Adjust in order given for maximum output.
7. "	"	1.6MC	"	1.6MC	"	A13	Adjust for maximum output. Repeat steps 6 and 7.
8. "	"	14.0MC	C	14.0MC	"	A14	Adjust for maximum output. If two peaks occur use the one closest to MINIMUM capacity.
9. "	"	"	"	"	"	A15	Adjust for maximum output. If two peaks occur use the one closest to maximum capacity.
10. "	"	5.0MC	"	5.0MC	"	A16	Adjust for maximum output. Repeat steps 8, 9 and 10.
11. "	"	30MC	D	30.0MC	"	A17	Adjust for maximum output. If two peaks occur use the one closest to maximum capacity.
12. "	"	"	"	"	"	A16	Adjust for maximum output. If two peaks occur use the one closest to MINIMUM capacity.
13. "	"	15.0MC	"	15.0MC	"	A19	Adjust A19 fully counter clockwise, then clockwise until second peak occurs. Adjust for maximum output on second peak. Repeat steps 11, 12 and 13.

PARTS LIST AND DESCRIPTIONS

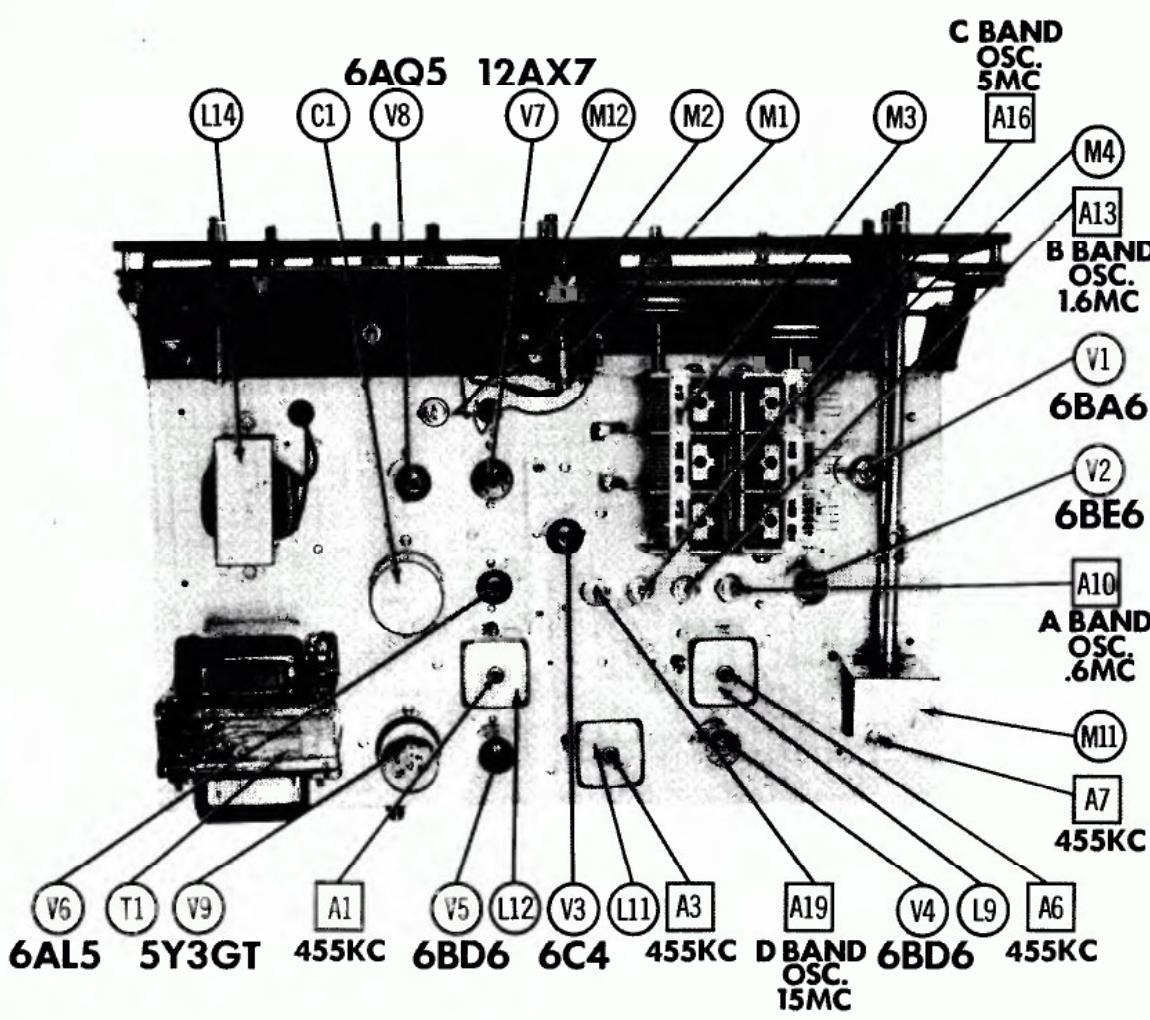
CHASSIS—TOP VIEW

TUBES (SYLVANIA, GENERAL ELECTRIC, WESTINGHOUSE)

ITEM No.	USE	REPLACEMENT DATA			NOTES
		NATIONAL PART No.	STANDARD REPLACEMENT	RETMA BASE TYPE	
V1	RF Amplifier Mixer	6BA4 6BE6	6BA6 6BE6	6BK	
V2	Oscillator	8C4	8C4	7CH	
V3	1st. IF Amplifier	6BD6	6BD6	6BG	
V4	2nd. IF Amplifier	6BD6	6BD6	7BK	
V5	Det. -ATC-Limiter	6AL5	6AL5	7BK	
V6	Meter Amp-BFO-				
V7	AF Amplifier	12AX7	13AX7	9A	
V8	Output Rectifier	6AQ5 5TGT	6AQ5 5TGT	7BZ	
V9				5T	

CAPACITORS

Capacity values given in the rating column are in mfd. for Electrolytic and Paper Capacitors, and in mmfd. for Mica and Ceramic Capacitors.



PARTS LIST AND DESCRIPTIONS (Continued)

PARTS LIST AND DESCRIPTIONS (Continued)

PARTS LIST AND DESCRIPTIONS (Continued)

CONTROLS

REPLACEMENT DATA				INSTALLATION NOTES			
ITEM No.	RATING	NATIONAL PART No.	IRC PART No.	CLEARCLAP PART No.	CENTRALAB PART No.	MALLORY PART No.	
R1A B	10KΩ Shaft	2	K349-3 Not Req.	A43-10K FS-3	B-6 U-6	R10,000L DS-36	Sensitivity/Wire Wound Attach to RIA Pitch
R2A B	1500Ω Shaft	4	K315-16 Not Req.	A47-2000-S FS-3	Not Req. U-48	40Ω	Band B-Freq. Range L. 540 - 1600KC
R3A B	500KΩ Shaft	1	K315-16 Not Req.	A47-500K-2 RS-2	Not Req. U-48	40Ω	Band B-Freq. Range L. 540 - 4.7MΩ
R4A B	1000Ω Shaft	1	K347-1 Not Req.	A47-500K-2 RS-2	Not Req. U-48	40Ω	Band C-Freq. Range 4.7MΩ - 14MΩ
				A48-1000 FS3-1/4	Not Req. U-48	28Ω	Band D-Freq. Range 14MΩ - 40MΩ
						29Ω	Band A-Freq. Range 14MΩ - 40MΩ
						RF Coll.	Band B-Freq. Range 1. 540 - 1600KC
						RF Coll.	Band C-Freq. Range 4.7MΩ - 14MΩ
						RF Coll.	Band D-Freq. Range 4.7MΩ - 40MΩ
						RF Coll.	Band A-Freq. Range 4.7MΩ - 40MΩ
						RF Coll.	Band B-Freq. Range 4.7MΩ - 14MΩ
						RF Coll.	Band C-Freq. Range 4.7MΩ - 14MΩ
						RF Coll.	Band D-Freq. Range 4.7MΩ - 40MΩ

RESISTORS

REPLACEMENT DATA				INSTALLATION NOTES			
ITEM No.	RATING	NATIONAL PART No.	IRC PART No.	NOTES	ITEM No.	NATIONAL PART No.	IRC PART No.
R5	470KΩ	J569-57	BTS-470K	R28	J569-54	BTS-270K	
R6	68Ω	J568-11	BTS-68	R29	J569-54	BTS-270K	
R7	47KΩ	J568-45	BTS-68	R30	J569-49	BTS-100K	
R8	15KΩ	J571-39	BTA-15K	R41	47KΩ	BTA-47K	Note 2
R9	684Ω	J569-11	BTS-68	R42	J569-73	BTS-10Meg	
R10	2200Ω	J568-29	BTS-2200	R23A	270KΩ		
R11	47KΩ	J568-45	BTS-47K	R23B	47KΩ		
R12	22Ω	J569-17	BTS-22	R24	47KΩ		
R13	33Ω	J569-17	BTS-33	R35	270Ω		
R14	150KΩ	J568-71	BTS-150K	R36	1500Ω		
R15	22Ω	J569-17	BTS-22	R27	2Ω		
R16	15KΩ	J569-15	BTS-150	R38	10Meg		
R17	22KΩ	J571-39	BTA-15K	R39	1Meg		
R18	270KΩ	J568-41	BTS-41	R40	2.2Meg		
R19	100KΩ	J568-54	BTS-270K	R41	6800Ω		
R20	100KΩ	J569-49	BTS-100K	R42	160KΩ		
R21	68Ω	J569-33	BTS-68	R43	100KΩ		
R22	100KΩ	J568-49	BTS-100K	R44	4700Ω		
R23	2200Ω	J569-29	BTS-2200	R45	4700Ω		
R24	2.2Meg	J568-65	BTS-2.2Meg	R46	500Ω		
R25	1Meg	J568-81	BTS-1Meg	R47	10Ω		
R26	1Meg	J569-81	BTS-1Meg	R48	10Ω		
R27		J569-81	BTS-1Meg		J569-1	BTS-10	

Note 1: Some models may use a 1500Ω resistor in this application.
 Note 2: Some models may use a 270Ω resistor in this application.
 Items R33A, R33B, C35A, C35B and C35C are combined in one unit.

MISCELLANEOUS

REPLACEMENT DATA				REPLACEMENT DATA			
ITEM No.	PART NAME	NATIONAL PART No.	PART No.	ITEM No.	NATIONAL PART No.	PART No.	NOTES
M1	Dial Light	F136-11					
M2	Dial Light	F136-11					
M3	Tuning Cap.	P-705-2					
M4	Tuning Cap.	P-706-2					
M5	Crystal	E-979-1					
M6	Switch	S-245-1					
M7	Switch	T-334-1					
M8	Switch	E220-2					
M9	Switch	T365-1					
M10	Crystal Filter Unit	SB2236					
M11	Meier	T366-1					
M12	Trimmer Cap.	D832-5					
M13	Trimmer Cap.	D832-5					
M14	Trimmer Cap.	E311-2					
M15	Trimmer Cap.	E311-2					
M16	Trimmer Cap.	E311-1					
M17	Trimmer Cap.	E311-2					
M18	Trimmer Cap.	E311-2					
M19	Trimmer Cap.	E311-2					
M20	Trimmer Cap.	E311-2					
M21	Trimmer Cap.	E311-2					
M22	Trimmer Cap.	E311-2					
M23	Trimmer Cap.	E311-2					
M24	Trimmer Cap.	E311-2					
M25	Trimmer Cap.	E311-2					
M26	Trimmer Cap.	E311-2					
M27	Trimmer Cap.	E311-2					
M28	Trimmer Cap.	E311-2					
M29	Trimmer Cap.	E311-2					
M30	Trimmer Cap.	E311-2					
M31	Trimmer Cap.	E311-2					
M32	Trimmer Cap.	E311-2					
M33	Trimmer Cap.	E311-2					
M34	Trimmer Cap.	E311-2					
M35	Trimmer Cap.	E311-2					
M36	Trimmer Cap.	E311-2					
M37	Trimmer Cap.	E311-2					
M38	Trimmer Cap.	E311-2					
M39	Trimmer Cap.	E311-2					
M40	Trimmer Cap.	E311-2					
M41	Trimmer Cap.	E311-2					
M42	Trimmer Cap.	E311-2					
M43	Trimmer Cap.	E311-2					
M44	Trimmer Cap.	E311-2					
M45	Trimmer Cap.	E311-2					
M46	Trimmer Cap.	E311-2					
M47	Trimmer Cap.	E311-2					
M48	Trimmer Cap.	E311-2					
M49	Trimmer Cap.	E311-2					
M50	Trimmer Cap.	E311-2					
M51	Trimmer Cap.	E311-2					
M52	Trimmer Cap.	E311-2					
M53	Trimmer Cap.	E311-2					
M54	Trimmer Cap.	E311-2					
M55	Trimmer Cap.	E311-2					
M56	Trimmer Cap.	E311-2					
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M59	Trimmer Cap.	E311-2					
M60	Trimmer Cap.	E311-2					
M61	Trimmer Cap.	E311-2					
M62	Trimmer Cap.	E311-2					
M63	Trimmer Cap.	E311-2					
M64	Trimmer Cap.	E311-2					
M65	Trimmer Cap.	E311-2					
M66	Trimmer Cap.	E311-2					
M67	Trimmer Cap.	E311-2					
M68	Trimmer Cap.	E311-2					
M69	Trimmer Cap.	E311-2					
M70	Trimmer Cap.	E311-2					
M71	Trimmer Cap.	E311-2					
M72	Trimmer Cap.	E311-2					
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M74	Trimmer Cap.	E311-2					
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M85	Trimmer Cap.	E311-2					
M86	Trimmer Cap.	E311-2					
M87	Trimmer Cap.	E311-2					
M88	Trimmer Cap.	E311-2					
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M90	Trimmer Cap.	E311-2					
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M93	Trimmer Cap.	E311-2					
M94	Trimmer Cap.	E311-2					
M95	Trimmer Cap.	E311-2					
M96	Trimmer Cap.	E311-2					
M97	Trimmer Cap.	E311-2					
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M99	Trimmer Cap.	E311-2					
M100	Trimmer Cap.	E311-2					
M101	Trimmer Cap.	E311-2					
M102	Trimmer Cap.	E311-2					
M103	Trimmer Cap.	E311-2					
M104	Trimmer Cap.	E311-2					
M105	Trimmer Cap.	E311-2					
M106	Trimmer Cap.	E311-2					
M107	Trimmer Cap.	E311-2					
M108	Trimmer Cap.	E311-2					
M109	Trimmer Cap.	E311-2					
M110	Trimmer Cap.	E311-2					
M111	Trimmer Cap.	E311-2					
M112	Trimmer Cap.	E311-2					
M113	Trimmer Cap.	E311-2					
M114	Trimmer Cap.	E311-2					
M115	Trimmer Cap.	E311-2					
M116	Trimmer Cap.	E311-2					
M117	Trimmer Cap.	E311-2					
M118	Trimmer Cap.	E311-2					
M119	Trimmer Cap.	E311-2					
M120	Trimmer Cap.	E311-2					
M121	Trimmer Cap.	E311-2					
M122	Trimmer Cap.	E311-2					
M123	Trimmer Cap.	E311-2					
M124	Trimmer Cap.	E311-2					
M125	Trimmer Cap.	E311-2					
M126	Trimmer Cap.	E311-2					
M127	Trimmer Cap.	E311-2					
M128	Trimmer Cap.	E311-2					
M129	Trimmer Cap.	E311-2					
M130	Trimmer Cap.	E311-2					
M131	Trimmer Cap.	E311-2					
M132	Trimmer Cap.	E311-2					
M133	Trimmer Cap.	E311-2					
M134	Trimmer Cap.	E311-2					
M135	Trimmer Cap.	E311-2					
M136	Trimmer Cap.	E311-2					
M137	Trimmer Cap.	E311-2					
M138	Trimmer Cap.	E311-2					
M139	Trimmer Cap.	E311-2					
M140	Trimmer Cap.	E311-2					
M141	Trimmer Cap.	E311-2					
M142	Trimmer Cap.	E311-2					
M143	Trimmer Cap.	E311-2					
M144	Trimmer Cap.	E311-2			</		